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THE WORLDWIDE TECHNOLOGY WEEKLY
SEPTEMBER 16, 1985

OPTICAL STORAGE: HOT ITEM OR A DUD?

SOME SAY
IT WILL SAVE
THE HOME COMPUTER
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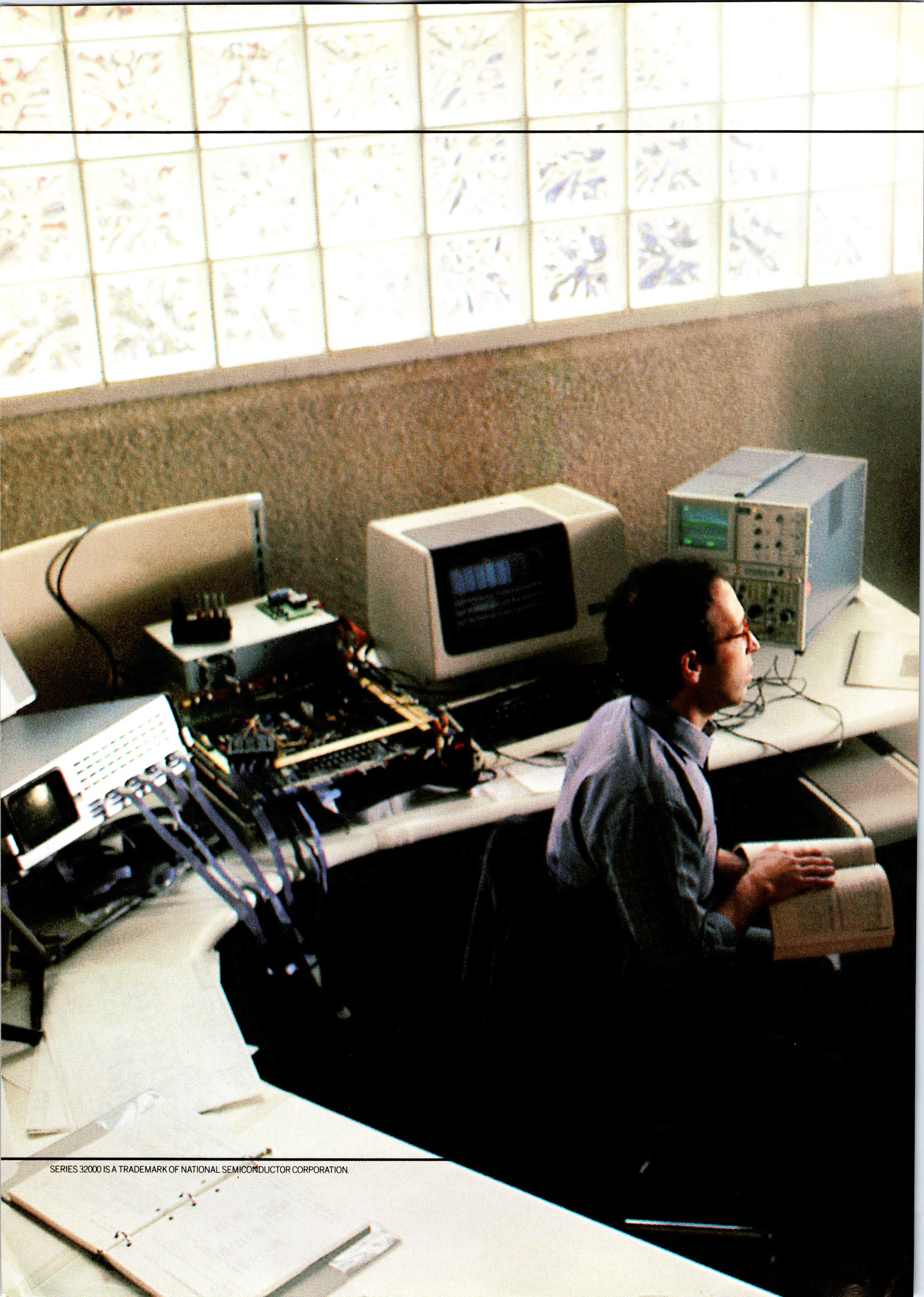

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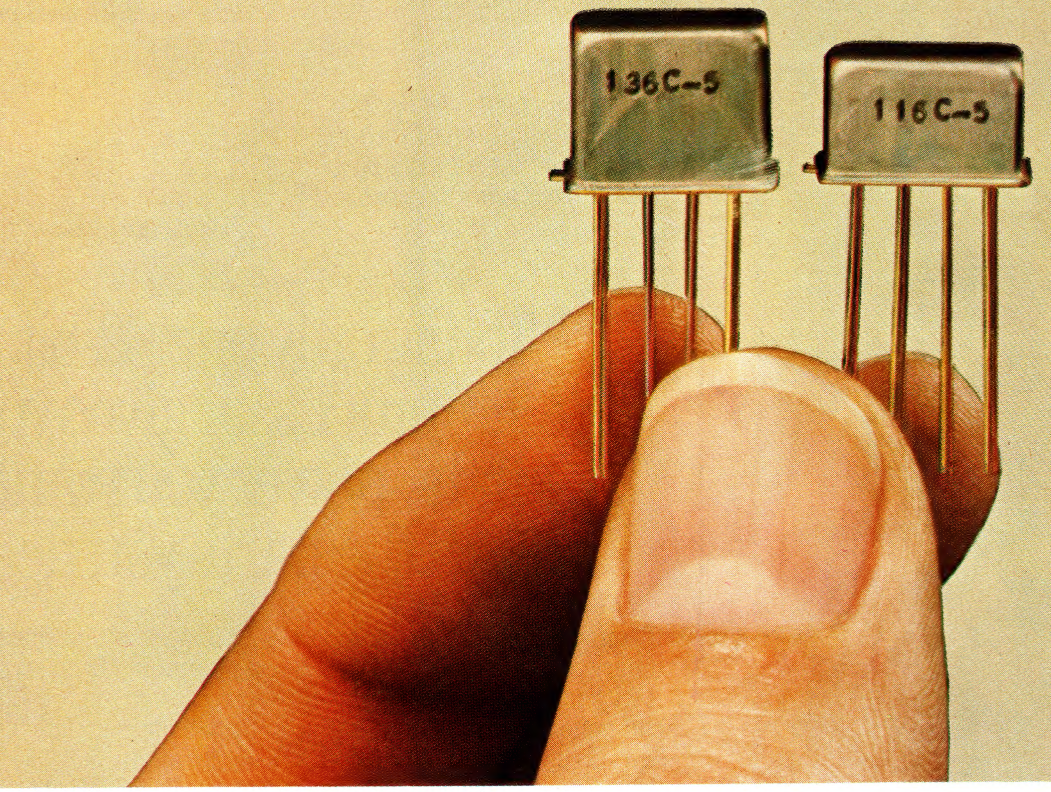

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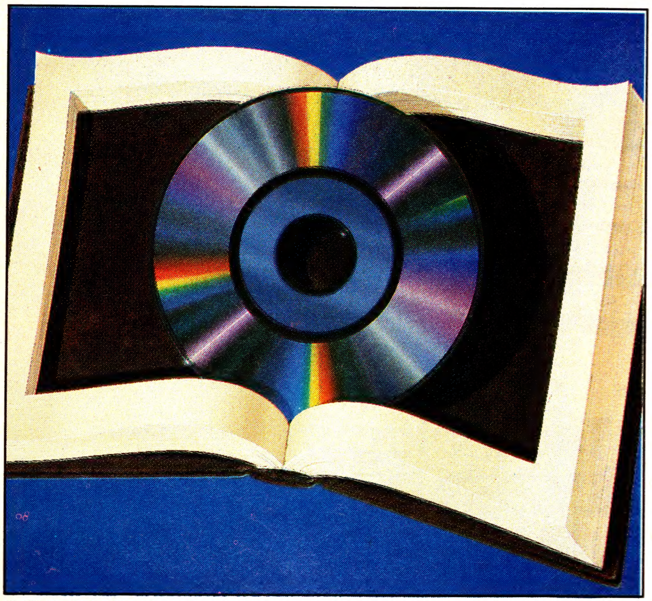

COVER: Optical storage: hot item or a dud? 26
Optical disk drives are coming on the market as personal-computer peripherals. These adaptations of compact-disk audio players are hailed by some as the salvation of the home computer but seen by others as a technology whose time may be five years from now
Cover illustration by art director Fred Sklenar

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Unmatched in Technology: AC POWER ANALYZER D 5155 AC/DC POWER ANALYZER D 5135 of NORMA

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D 4135 IEC 625	MULTI-FUNCTIONMETER	0–150 kA / 500 V 75 MW
D 4155 IEC 625	PRECISION WATTMETER	0–10 A / 550 V / 11 kW
D 5155 IEC 625	AC POWER ANALYZER	0–50 A / 650 V / 100 kW
D 5135 IEC 625	AC/DC POWER ANALYZER	0–100 A / 500 V / 50 kW
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PUBLISHER'S LETTER

ON THE CDROM BEAT. Caruso finds even the skeptics go for the optical memory.

Skepticism is the best friend of the experienced reporter. This is particularly true in an area of high technology such as electronics, where "breakthroughs" are as common as head colds in February—but true breakthroughs are very rare indeed. So Denise Caruso of our Palo Alto bureau, who has both daily-newspaper and industry-magazine experience, was routinely skeptical when she was assigned to do this week's cover story about the compact-disk read-only memory, "Optical storage: hot item or a dud?"

"I wasn't really convinced that CDROMs are going to be the next hot item," says Denise, who has a degree in English from California Polytechnic Institute at San Luis Obispo. "But then when I started talking to people who watch the industry, I was impressed.

"Even the skeptics among them—those who do not agree that disk players as personal computer peripherals will come on big next year—think that it is a powerful technology for the future. The differences of opinion seem to revolve around just when that future will arrive, and there even the skeptics talk about wider acceptance in five years. One thing is sure—no one that I spoke to would say flat out that CDROMs will never catch on."

That assessment matches that of the *Electronics* editors who first saw the technique demonstrated at June's National Computer Conference and then in July visited Activenture Corp., a pioneer in CDROMs, to take a closer look at the technology. It also agrees with the findings of the field editors who contributed to Denise's report—Charlie Cohen in Tokyo, Wes Iversen in Chicago, Rob Lineback in Dallas, Craig Rose in Boston, Tobias Naegele in New York, and George Leopold in Washington.

Now, having written the article—it begins on p. 26—Denise marvels at the potential of the CDROM. "When I think of how frustrating it is to try to remember something I read in The *New Yorker* four or five months ago, I realize the potential of those little compact disks. Using tapes from the typesetting process, a whole year's worth of any magazine could be put on just a small portion of a CD."

The result is that Denise, who moved with her family to San Luis Obispo from Detroit 19 years ago at the age of 10, has become a convert. But as for a prediction about when CDROM technology will flower, Denise is cagey—too much the careful reporter to commit herself. "The consensus is between now and 1990. And that's all I'm willing to say."

Laurence Altman

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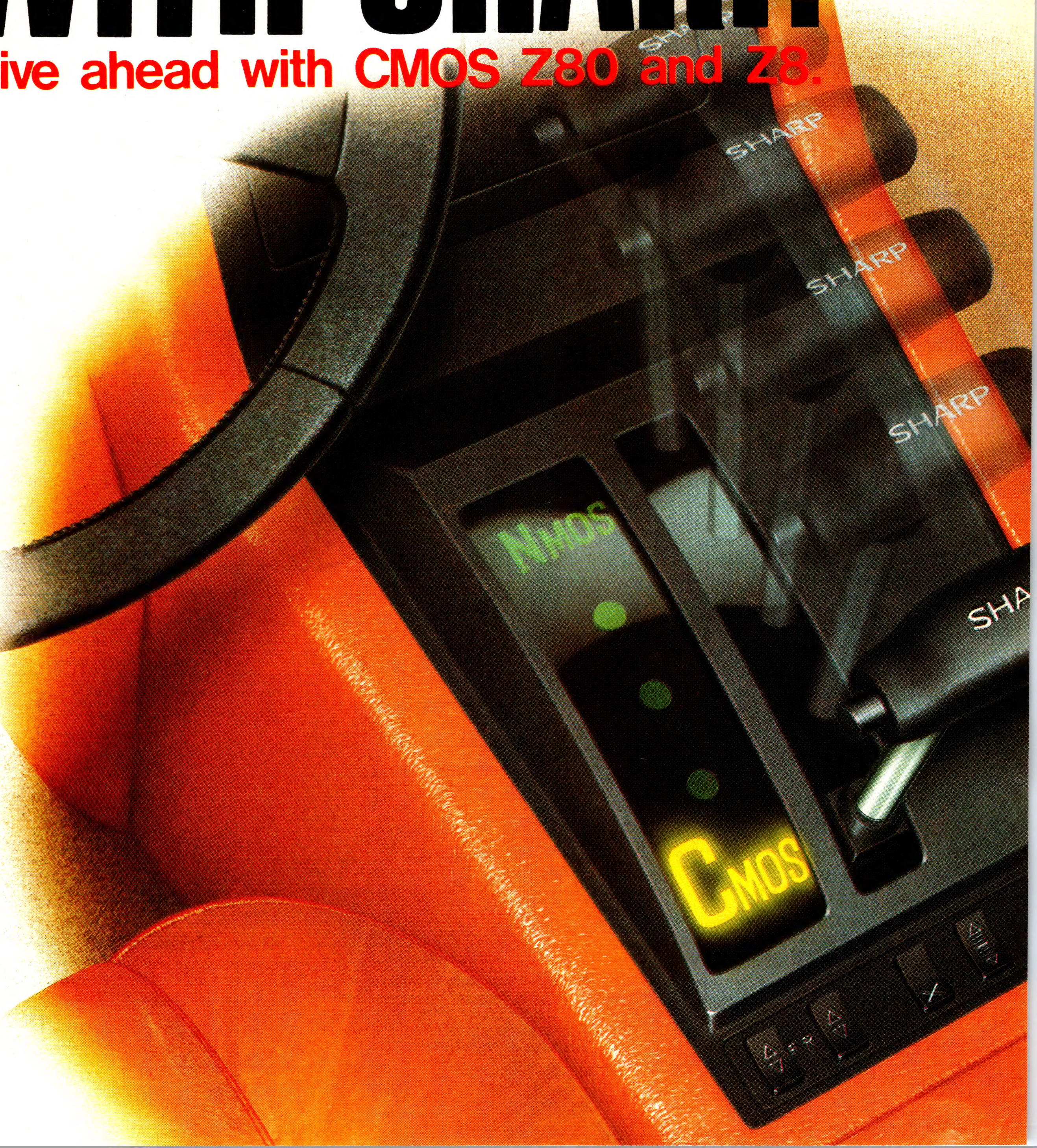

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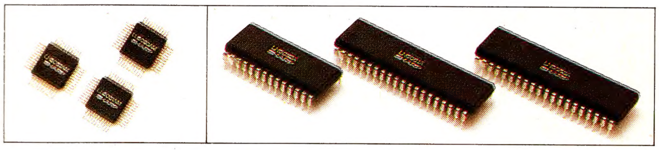

Z80 CMOS Family (8-Bit CMOS Microcomputers)

Type No.	Description	Features	Package
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LH5080L LH5080LM LH5080AL LH5080ALM		● Equivalent to LH5080. ● Power-save mode with the execution of HALT instruction. ● 50μA (TYP.) in power-save mode.	
LH5081 LH5081M LH5081A LH5081AM	Parallel I/O controller	● Compatible with LH0081 (Z80 PIO) of NMOS process. ● Fully static operation. ● 2mA (TYP.) supply current.	40 DIP 44 QFP
LH5081L LH5081LM LH5081AL LH5081ALM		● Equivalent to LH5081. ● Power-save mode with the execution of HALT instruction. ● 50μA (TYP.) in power-save mode.	
LH5082 LH5082M LH5082A LH5082AM	Counter timer circuit	● Counter/timer device which is compatible with LH0082 (Z80 CTC) of NMOS process. ● Fully static operation. ● 2.5mA (TYP.) supply current.	28 DIP 44 QFP
LH5082L LH5082LM LH5082AL LH5082ALM		● Equivalent to LH5082. ● Power-save mode with the execution of HALT instruction. ● 50μA (TYP.) in power-save mode.	

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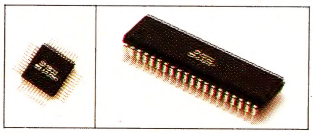

Z8 CMOS Family (8-Bit CMOS 1-Chip Microcomputers)

Type No.	Cycle time MIN. (μS)	Supply voltage (V)	Current consumption TYP. (mA)	No. of inputs/outputs	ROM (bit)	RAM (bit)	Subroutine nesting level	Package	Remarks
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LU800V1	2.2	5	12	32	—	128x8	Uses RAM area	40DIP 44QFP	For development of SM803 For pilot production

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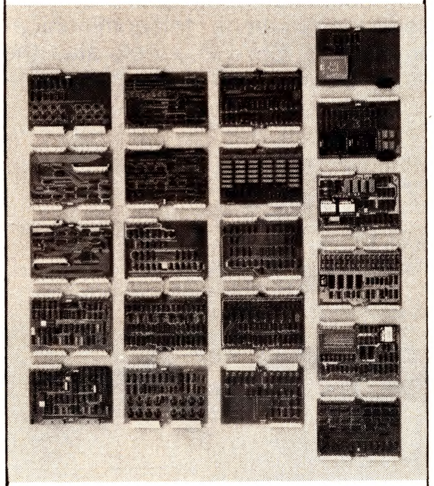

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MEETINGS

Autotestcon '85: International Automatic Testing Conference, IEEE (Long Island Tourism & Convention Commission, Nassau Veterans Memorial Coliseum, Uniondale, N. Y. 11553), Long Island Marriott, Uniondale, N. Y., Oct. 22-24.

Apics 28th International Conference and Technical Exhibit, American Production & Inventory Control Society Inc. (500 W. Annandale Rd., Falls Church, Va. 22046-4274), Convention Centre, Toronto, Oct. 22-25.

8th International Conference on Pattern Recognition, International Association of Pattern Recognition (Association Française pour la Cybernétique Economique et Technique, ICPR Secretariat, 156, Blvd. Péreire, 75017 Paris, France), Palais des Congrès, Paris, Oct. 28-31.

Federal High Tech '86, National Science Foundation, U. S. Department of Energy *et al.* (Foresight Science & Technology Inc., 2000 P St., N. W., Suite 305, Washington, D. C. 20036), Amfac Hotel and Resort, Dallas, Oct. 29-30; Marriott Copley Place, Boston, Nov. 25-26.

Electronic Displays '85, Networks Events Ltd. (Printers Mews, Market Hill, Buckingham, MK18 1JX, England), Kensington Exhibition Centre, London, Oct. 29-31.

Electronic Packaging: Materials and Processes, American Society for Metals (Metals Park, Ohio 44073), Registry Hotel, Bloomington, Minn., Oct. 29-31.

Electronics Production Technology, Components, Instrumentation, Test and Measuring Equipment Exhibition, Industrial and Trade Fairs International Ltd. (Radcliffe House, Blenheim Ct., Solihull, West Midlands B91 2BG, England), Taj Mahal Hotel, Bombay, India, Oct. 29-31.

Computer and Electronics Show, IEEE (Daniels Productions Inc., 1155 New Britain Ave., West Hartford, Conn. 06110), Civic Center, Hartford, Conn., Nov. 1-2.

Conference on Advanced Medical Computer Applications, Princess Grace Hospital (Hippocrate 2001, Princess Grace Hospital, Monte Carlo), Congress Center, Monte Carlo, Nov. 4-6.

Autofact '85 Conference and Exposition, Society of Manufacturing Engineers (SME, P. O. Box 930, Dearborn, Mich., 48121), Cobo Hall, Detroit, Nov. 4-7.

International Electronic Components Exhibition, French Federation of Electrical and Electronics Industries (SDSA, 20 rue Hamelin, 75116 Paris, France), North Paris Exhibition Grounds, Paris, Nov. 4-8.

Gomac-85: Government Microcircuit Applications Conference, Department of Defense *et al.* (Palisades Institute for Research Services Inc., 201 Varick St., Suite 1140, New York, N. Y. 10014), Marriott Hotel, Orlando, Fla., Nov. 5-7.

ISHM '85: International Symposium on Microelectronics, International Society for Hybrid Microelectronics (P. O. Box 3255, Montgomery, Ala. 36109), Disneyland Hotel, Anaheim, Calif., Nov. 11-14.

1st International Conference and Exhibit on Computer Work Stations, IEEE (1109 Spring St., Suite 300, Silver Spring, Md. 20910), Convention Center, San Jose, Calif., Nov. 11-15.

1985 GaAs IC Symposium, IEEE (James A. Hutchby, Technical Program Chairman, Research Triangle Institute, P. O. Box 12194, Research Triangle Park, N. C. 27709), Monterey Conference Center, Monterey, Calif., Nov. 12-14.

Quality Expo TIME-West, Quality Magazine (Quality Expo TIME-West, 2400 E. Devon Ave., Suite 205, Des Plaines, Ill. 60018), Convention Center, Los Angeles, Nov. 12-14.

International Conference on Systems, Man and Cybernetics 1985, IEEE (Russ Ferrell, Systems and Industrial Engineering Department, University of Arizona, Tucson, Ariz. 85721), Holiday Inn-Broadway, Tucson, Nov. 12-15.

Productronica 85: 6th International Trade Fair for Electronics Production, Münchener Messe-und Ausstellung GmbH (Productronica 85 Project Office, Münchener Messe-und Ausstellung GmbH, Postfach 12 10 09 D-8000 Munich 12, West Germany), Trade Fair Center, Munich, Nov. 12-16.

Iecon '85: 11th IEEE Industrial Electronics Society Conference, IEEE (Ravi Prakash, Thomas J. Watson Research Center, Mail Stop 3-249, P.O. Box 218, Yorktown Heights, N. Y. 10598), Hyatt Regency, San Francisco, Nov. 18-22.

Wescon '85, IEEE (Electronics Conventions Management Inc., 8110 Airport Blvd., Los Angeles, Calif. 90045), Moscone Convention Center, San Francisco, Nov. 19-22.

Comdex/Fall '85, The Interface Group Inc. (300 First Ave., Needham, Mass. 02194), Convention Center *et al.*, Las Vegas, Nev., Nov. 20-24.

Globecom '85: IEEE Global Telecommunications Conference, IEEE (G. A. Ledbetter, South Central Bell, 365 Canal St., New Orleans, La. 70140) Hyatt Regency, New Orleans, Dec. 2-5.

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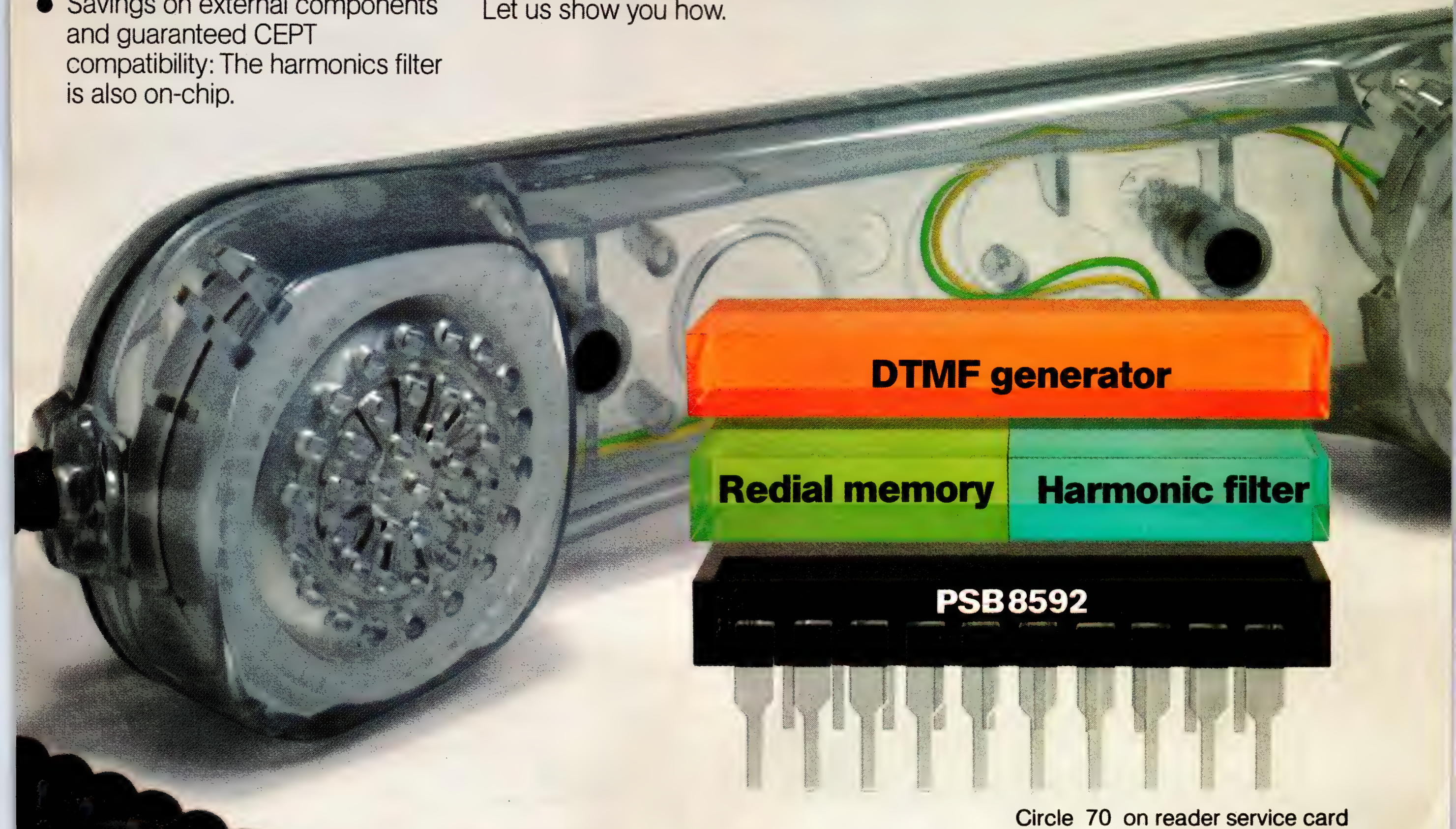

Circle 70 on reader service card

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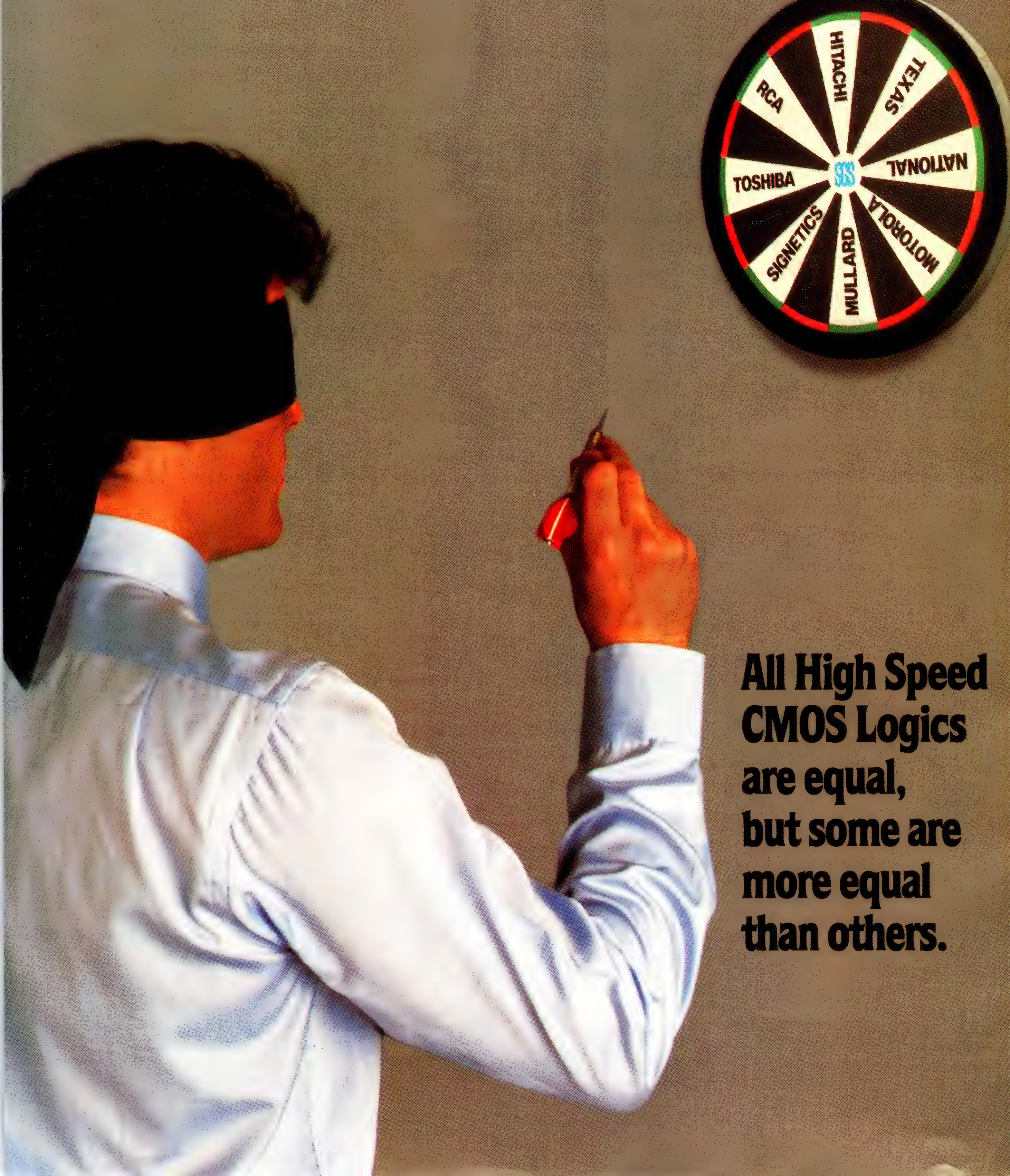

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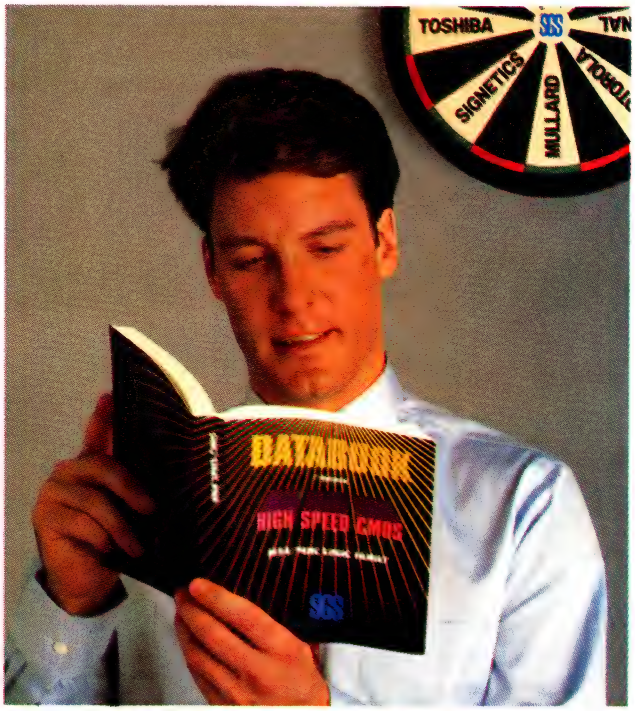

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Ethernet

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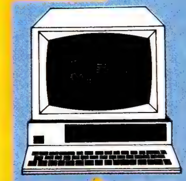

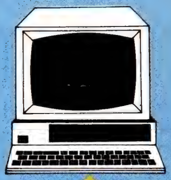

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ELECTRONICS NEWSLETTER

TI IS CLOSE TO ANNOUNCING A NEW LOW-POWER BIPOLAR PROCESS

Look for another bound in bipolar technology in the next six months or so from Texas Instruments Inc. During that time, the Dallas chip maker is expected to disclose details on an as-yet-unannounced oxide-isolation technology that improves device speed and power dissipation by 30% to 40% compared to TI's most advanced bipolar production process, the 1.5-μm Impact-X. Impact-X, a shrunken version of the 2-μm Impact technology with a 1-picojoule speed-power product, was introduced in 1983. But the new technology will be much more than another enhancement of Impact, the company insists. The new bipolar technology will be used in field-programmable logic, bipolar memories, bit slices, first-in first-out circuits, multipliers, floating-point processors, and other very large-scale integrated circuits. ☐

OUTLOOK IMPROVES FOR PANELVISION, THANKS TO NEW PARENT

Prospects for success now look better for the active-matrix-driven flat-panel liquid-crystal-display technology pioneered by Panelvision Corp., thanks to the backing of a new corporate parent. Facing inadequate funding and heavy competition from Japan, the five-year-old Pittsburgh company founded by ex-Westinghouse researchers was acquired quietly in mid-June by Litton Systems Inc., a subsidiary of Litton Industries Inc., Beverly Hills, Calif. Litton won't say what it paid for the operation, now known as the Panelvision Division. But Panelvision reportedly went for a fire-sale price after it failed in a widespread search to raise money from a corporate investor. Out at Panelvision is T. Peter Brody, principal founder and the brains behind the company's cadmium selenide thin-film-transistor technology [*Electronics*, Nov. 17, 1983, p. 14].

Panelvision's new owner will concentrate on producing a militarized version of the company's MiniGraphic, a 4-by-5-in. LCD flat-panel display brought out last year [*Electronics*, May 31, 1984, p. 109], says William C. Jurocko, the division's new general manager. ☐

INTELSAT MOVES TO LINK UP WITH INTERSPUTNIK

Intelsat and its Soviet counterpart, Intersputnik, are feeling their way toward an integrated satellite system. The board of governors of the International Telecommunications Satellite Organization decided last week to advise its 109 member-countries to approve a plan for Intelsat to coordinate reception of TV programming from the Soviet Union through 1990. The broadcast signal would be relayed from the Soviet Ghorizont-7 satellite. Intelsat says U. S. reception from Ghorizont-7 will extend existing services provided to the Intersputnik system's members. Jose Alegrett, Intelsat's deputy director for business planning, says the decision is part of an effort to integrate the two systems, which still differ in coverage areas. Intelsat opted for the new tie as a counter to a recent Federal Communications Commission decision that allows limited competition to Intelsat services from three private satellite companies. ☐

RISE IN SEMICONDUCTOR BOOK-TO-BILL IS DUE TO MATHEMATICAL QUIRK

Even though semiconductor bookings were down slightly and billings were up slightly, the overall industry book-to-bill ratio rose by 0.02 to 0.74 in August, says the Semiconductor Industry Association. The mathematical anomaly is due to the fact that the ratio is calculated according to a three-month rolling average, and the month that dropped off, May, had exceptionally high billings, says an SIA representative. Otherwise, there was little change in the market last month. Third-quarter shipments are running 13% below the second quarter, and the SIA now projects a drop of 28% in billings from 1984 to 1985. ☐

SEPTEMBER 16, 1985

ELECTRONICS NEWSLETTER

APPLE ABOUT TO UPGRADE ITS APPLE II AND MACINTOSH

Apple Computer Inc. presumably will quell this week the clamor for innovation that has been increasing in recent months from users and third-party software developers. The Cupertino, Calif., company is expected to announce several upgrades to its Apple II and Macintosh product lines. Among them are a 20-megabyte external hard disk for the Macintosh; 300-K-byte, double-sided, 3-½ in. floppy-disk drives and a memory-expansion board that allows the addition of 256-K bytes to 1 megabyte of random-access memory for the II line; and the Imagewriter II, an expandable color printer with two open card slots—one for a 32-K-byte print buffer and another for an interface to the still-unshipped Appletalk low-cost local-area network. The new printer's price is expected to be about $400, the same as the original Imagewriter. ☐

AMD CALLS FOR 'LIBERTY CHIP' PRODUCTION

A product introduction every week may be steep, but Advanced Micro Devices Inc. plans to do exactly that starting Oct. 1 and continuing for 52 weeks. The blitz—aimed mostly at expediting the availability of advanced integrated-circuit designs—is intended to help lead the Sunnyvale, Calif., company out of the severe industry slump. For one year, AMD will be putting its "reputation as an innovator on the line," states W. J. (Jerry) Sanders III, company president, who unveiled the aggressive campaign at last week's annual shareholders' meeting at AMD's expanding plant site in Austin, Texas. "Because the new ICs offer us freedom from the tyranny of the commodity marketplace, I call them 'liberty chips,' " says Sanders, who indicates that much of the company's effort will aim at keeping Japanese producers in check. Introductions will include MOS and bipolar ICs that have already been disclosed in recent months, such as the Am27C1024 1-Mb erasable programmable read-only memory [*ElectronicsWeek*, April 22, 1985, p. 52]. ☐

UNCLE SAM IS BECOMING THE NO. 1 CUSTOMER FOR PERSONAL COMPUTERS

Personal computer makers ensnared in the current business slump have found that the U. S. government could be their biggest customer. With a data-processing budget of about $15 billion, the federal government is quickly becoming the largest buyer of personal computers. By 1990, all 1.4 million white-collar federal employees could have a personal computer on their desks, estimates the Government Services Administration. Government offices had about 100,000 personal computers at the end of 1984, according to GSA surveys. But it is difficult to estimate how many computers the government is purchasing because agencies have discretionary budgets for data processing that range from $2.5 million to $10 million. The Internal Revenue Service, for example, is buying about 20,000 lap-type computers. ☐

MICROSOFT SHIPS SYSTEM V XENIX TO OEMs

Expect to see introduced between now and the November Comdex show at least a half dozen new multiuser work stations that will run a version of Microsoft Corp.'s Xenix operating system and be compatible with Unix System V. The Bellevue, Wash., company began shipping System V Xenix this week to original-equipment manufacturers and independent systems vendors.

Xenix, a binary version of AT&T Bell Laboratories' Unix, is tied to Intel Corp.'s 80286 architecture. With an installed base of more than 110,000 systems, Microsoft already claims two thirds of the Unix market for its System III version of Xenix. It's switching to System V, says product manager Adrian King, because large corporations and the federal government are beginning to insist on it for new installations. ☐

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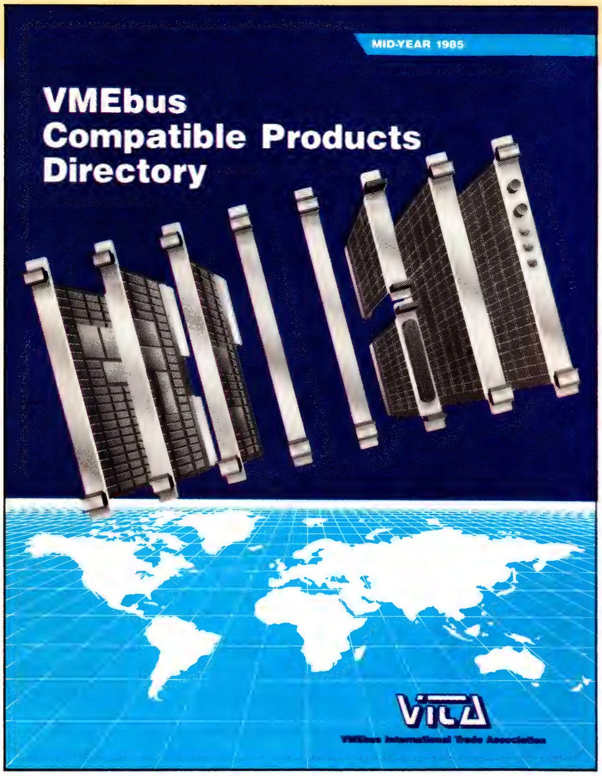

MID-YEAR 1985

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Electronics

A BOOM IN R&D CONSORTIUMS: 45 ARE IN THE WORKS

LATEST IS SOFTWARE GROUP BEING SET UP BY 15 AEROSPACE FIRMS

WASHINGTON

At least 10 electronics-related consortiums have formed since the National Cooperative Research Act last fall swept away antitrust barriers to collaborative research and development. The latest, the Software Productivity Consortium, which joins the forces of 15 aerospace companies, will be formally launched at the Virginia Center for Innovative Technology next week.

"We've seen a remarkable bubbling of activity. New consortiums keep popping up all over, with two to three notifying the Justice Department each month," says Bruce Merrifield, assistant secretary of commerce for productivity, technology, and innovation.

Since the law was changed last fall [*ElectronicsWeek*, Nov. 5, 1984, p. 37], 45 groups of companies have have set up or proposed R&D consortiums covering fields ranging from new cement-making methods to new TV-transmission techniques. The Software Productivity Consortium joins the ranks of the Semiconductor Research Corp., the Microelectronics & Computer Technology Corp., and a host of others (see "A dozen consortiums relate to electronics," opposite).

The main goal of these consortiums is to pool research efforts, thereby speeding product development and increasing productivity. But U. S. companies will also need initiatives from government and private industry to meet Japan's competitive threat, said several observers at the Federal Computer Conference, where the consortiums were a major topic of conversation.

By combining resources and talent and overcoming the "immediate profit-and-loss mentality" of American management, consortiums offer the advantage of being able to focus on long-term research and to generate results much faster than a single company can. "Our work will eventually make a one- to two-year difference in getting a new product to market," predicts Palle Smidt, senior vice president at Microelectronics & Computer Technology.

For example, without the Software Productivity Consortium, "meeting the mission-critical software demands of the Department of Defense would be impossible," says D. J. Alley, director of missile and space research at Lockheed Corp. Aerospace companies are now hiring 4% more software engineers a year. "But we need to be hiring three times more than that to satisfy a DOD market that will triple from $10 billion today to $30 billion by 1990," estimates Alley.

MORE PRODUCTIVE. "To wash out the expected deficit in people, we must make each engineer more productive," he explains. With a staff of 135, an annual budget of $15 million and a centralized structure similar to that of MCC, the Software Productivity Consortium will aim to increase engineering productivity by 4 : 1 over the next five years and 10 : 1 within 10 years. It will concentrate on reusable software modules, an approach with which Japanese companies have demonstrated a 90% success factor, although in a narrow domain, he says. The consortium will also undertake development of rapid-prototyping tools and knowledge-base systems.

MATCHMAKER. The Commerce Department's Bruce Merrifield wants to see more consortiums for research and development.

Merrifield expects these consortiums to break the ice for many more associations now in the planning stages. He hopes groups will be formed to develop a 4-Mb dynamic random-access memory chip and gallium arsenide ballistic transistors [*ElectronicsWeek*, April 1, 1985, p. 22]. The assistant secretary wants the semiconductor industry to lead the way, but Semiconductor Research Corp. president Larry Sumney believes the industry's most pressing need is semiconductor manufacturing technology.

The growing costs and complexity of manufacturing are killing the U. S. industry, Sumney claims. What is needed is an MCC-type venture to conduct generic R&D on manufacturing equipment. Unless U. S. industry can drive down production costs, "we will continue to see the pattern whereby the U. S. innovates the design and Japan locks onto it and sells it at a price we can't beat," he says.

But consortiums alone can't offset the Japanese advantage coming from vertical integration, says Kermith H. Speierman, chief scientist at the National Security Agency. Though it is not reasonable to call on U. S. industry to restructure along Japanese lines, Speierman thinks an alternative that "builds off our free enterprise system" is what he calls vertical cooperation.

INTIMACY. Vertical cooperation, he explains, involves a much more intimate relationship between buyers and sellers. Through much closer interaction with chip makers, for example, computer companies could gain the assurance of knowing that components packaged to meet their needs would be available. In turn, IC vendors would face greater market certainty.

Figuring out what government should do to help, however, is much more difficult, since "we're likely to do more harm than good" through interference, Speierman says. But a program similar to the Very High-Speed Integrated Circuits effort directed at microelectronics manufacturing would be a good idea and represent the best kind of government-industry collaboration, he suggests.

Merrifield, however, believes the government should concentrate on removing regulatory barriers. "There are literally hundreds of well-intentioned, industry-specific regulations that impede the ability of U. S. companies to compete worldwide," asserts Merrifield, who wants to eliminate all of them.

He isn't finished reforming antitrust law either. His next target is Section 7 of the Clayton Act, which provides the legal basis for challenging mergers and acquisitions. He says the law prevents some U. S. industries from achieving economies of scale. A revision could pave the way for joint corporate manufacturing. Then only shared marketing would be out of the legal reach of industry partnerships. *–Karen Berney*

A DOZEN CONSORTIUMS RELATE TO ELECTRONICS

Since the National Cooperative Research Act went into effect last fall, some 45 research and development consortiums have been set up or planned to allow industry, government, and academic institutions to join forces in a wide range of fields. Among those doing research related to electronics are:

- Software Productivity Consortium—15 aerospace defense companies.
- Microelectronics & Computer Technology Corp.—21 members.
- Bell Communications Research Inc. (Bellcore)—members of regional Bell operating companies.
- Computer Aided Manufacturing International—over 50 members.
- Center for Advanced Television Studies—ABC, NBC, CBS, PBS, RCA, HBO, 3M, Ampex, Harris, and Tektronix.
- Uninet Research and Development Co.—Uninet Inc. and Control Data Corp.; R&D on advanced packet switching.
- United Technologies/Toshiba Corp.—fuel-cell power plants.
- Bellcore and Honeywell Information Systems—gallium arsenide ICs.
- International Partnership in Glass Research—ACI Ventures, Weigand & Soehne, Brockway, Emhart Glass Research, Portion Research, Rockware Glass, Yamahura Glass.
- Bellcore/U. S. Department of the Army—GaAs circuits.
- Bellcore/Racal Data Communications—interexchange connectivity and image conferencing systems.
- Bellcore/Avantek—telecommunications exchange and access services.
- Semiconductor Research Corp.—34 members.

TEST & MEASUREMENT

A FASTER WAY TO CHECK STRESS ON ATTACHED DIE

GAITHERSBURG, MD.

Researchers at the Philips Research Laboratories in Sunnyvale, Calif., have come up with a fast way to make the die-curvature measurements needed to determine the residual stresses on multilayer structures after semiconductor-die attachment. The method, useful in evaluating die adhesives, uses an automated interferometer and a minicomputer to produce a measurement in only 5 minutes, the researchers say.

Described last week in Gaithersburg at the VLSI Packaging Workshop, the technique uses an automated Fizeau interferometer connected to a low-power scanning microscope with a zoom objective to measure the radius of a die's curvature after attachment. The fringes of the curved surface of a bare, polished die are analyzed using a digital video camera and a Digital Equipment Corp. PDP-11 minicomputer.

"Because bare, polished dice are used, this method has certain advantages over the test chip with the strain gauges [fabricated on it] we have used in the past," explains Cees G. M. van Kessel, senior scientist at the Philips lab and coauthor, with Stephen A. Gee and James J. Murphy, of a paper on the technique. One advantage, van Kessel says, is that it requires no initial strain-gauge readings. Older methods often needed such measurements in three directions.

Philips's system uses off-the-shelf parts

The Philips design, which has been in development for about one year, uses commercially available parts, such as a helium-neon laser, for the optical and mechanical components. The zoom objective can adapt image magnification to different sample sizes and fringe densities. A version of the system using a less powerful computer can be designed for about $10,000.

In making the final calculation of the radius of the curvature, the method assumes the die surface is nearly spherical. "The validity of this assumption is checked by the variance of the least-squares fit to the fringe positions," van Kessel says. The result is a contour map of the die.

The interferometer system has recently been used for the evaluation of different die adhesives, but van Kessel was unable to provide current data. Another application, he says, is measuring stresses in thin planar films of silicon nitride on 4-in. wafers. *–George Leopold*

COMPANY STRATEGIES

IC FIRMS REALIGN AS CUSTOMERS SHIFT

SUNNYVALE, CALIF.

A new organizational fad is spreading rapidly through the U. S. semiconductor industry, as major companies reposition themselves to get off the blocks faster when the next boom arrives. Chip makers such as Motorola, Texas Instruments, Fairchild Camera & Instrument, Signetics, Intel, and Advanced Micro Devices have completely reorganized their operations—breaking up old units, creating new ones, and merging technology sectors.

They are making their operations more customer-oriented and are realigning along market, rather than process, lines because customers are becoming far more interested in the product than the process."Technology itself is beginning to merge and that is creating some new problems for the industry," says Doug Powell, director of strategic marketing for Motorola Inc.'s Semiconductor Product Sector. "A good example is MOS and bipolar—BiMOS—and power devices," he says. "Microprocessors and application-specific ICs are basically on a collision course as well. You have to ask yourself if the company is organized in such a manner that it can handle these emerging trends."

Motorola reacted by putting bipolar and MOS processes together under each of two customer groupings to replace the old setup of one group for each process. The Standard Logic and Analog IC Group and the Application-Specific IC Division both cover bipolar and MOS processes, and both are located in Mesa, Ariz. Microprocessor and memory businesses are run out of separate groups: the Microprocessor Products Group and the MOS Memory Products Group, both in Austin, Texas.

This pattern of combining process-technology sectors was also seen in the shuffling last July at the world's largest IC maker, Texas Instruments Inc. In an attempt to capitalize on the broad range of its long-time customers, the Dallas

SERVICE. James B. Downey, senior vice president of operations at AMD, says reorganization lets his company "better serve the marketplace."

company put HCMOS and bipolar logic together—along with several other product lines including ASICs—under one vice president, Delbert A. Whitaker. He says that placing bipolar and HCMOS (and eventually emitter-coupled logic as well) under the same logic operation allows TI's chip designers and customers to use any of the company's processing technologies to get the job done.

GETTING IT DONE. Such a philosophy also characterizes the spirit behind the reorganization begun last October at Fairchild Camera & Instrument Corp., Mountain View, Calif. Though focusing on the three major businesses of logic, memory, and analog parts, it is currently split into six product-line-based business units. The restructuring is incomplete, as the company is still implementing the decentralist policies of parent Schlumberger Ltd., which acquired it in 1980. However, every unit has MOS and bipolar processes.

Merging technologies are creating some new problems

"It is important that each unit have all the tools to address the problem from a system level," says Peyton M. Cole, manager for strategic marketing and communications. He also believes that in the long term, application-specific products will be seen in all divisions of his company.

Signetics Corp., Sunnyvale, followed in May when it united its MOS and bipolar product divisions. Last month, it added a new strategic marketing group to better follow key worldwide markets.

For its part, Intel Corp., Santa Clara, Calif., recently upgraded the stature of application-specific products by putting senior vice president Jack Carsten in charge of that line.

AMD, like the other major companies, has made use of the slack time to restructure according to market definitions. "By organizing to the specific function a device performs in our customer's systems, rather than to the technology used to produce that device, we will be better able to serve the marketplace and react faster to new product potential," says James B. Downey, senior vice president of operations.

Product modification, one market function, will fall into the Special Logic Group. This group covers all of AMD's custom and semicustom work, where previously there were separate groups for each. Two other new major business units are the Memory Group and the General Logic Group. AMD's business in dynamic random-access memories, however, falls under the Advanced Technology Division, a fourth new group.

Mel Phelps, senior technology analyst at Hambrecht & Quist Inc., a San Francisco investment company, notes that, perhaps not by coincidence, both Intel and AMD have good CMOS programs—a key ingredient "to ride in the mainstream of the semicustom business."

But he also believes that "behind this emerging customer-services orientation is the idea that from it will emerge many standard products. After all, that was the way the microprocessor was developed at Intel." *–Eve Bennett and J. Robert Lineback*

MILITARY

SMART BATTLEFIELD MAP TRACKS FRIEND AND FOE

NORWALK, CONN.

Norden Systems is moving into the final stages of development for the Marine Integrated Fire and Air Support System, a computerized battlefield command system capable of coordinating the activities of every soldier in a Marine battalion.

Five years in development, Mifass centers around a sophisticated map display that can detail the positions of both friendly and enemy ground and air forces. Using a variety of analog and digital communications techniques, the system can coordinate those units, ordering advances and retreats on the ground, as well as artillery and air fire.

Because modern warfare demands that a vast amount of data be quickly gathered and analyzed, Mifass was designed to make decisions in real time, says David Sturtevant, systems engineering manager for the Mifass program at the Norwalk-based division of United Technologies Corp. The system can receive and transmit continuously updated data on both friendly and enemy positions.

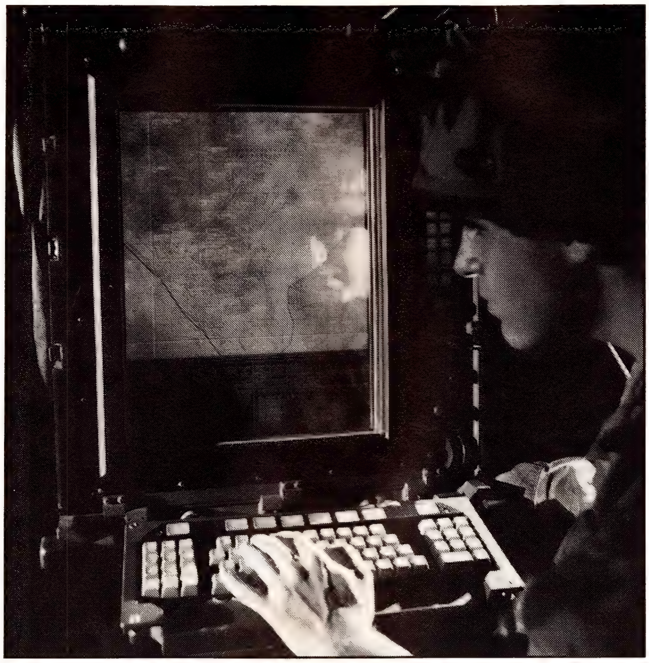
Battalions will get real-time decision making

LOCATION SYSTEM. Mifass connects with PLRS, the Position Location and Reporting System developed by Hughes Aircraft Co. to track the coordinates of all personnel involved in a mission. "Ultimately, every unit would have a PLRS device," says Sturtevant, who says the PLRS transmitters will be located in airplanes, helicopters, ground vehicles, and in backpacks worn by infantrymen.

Developed with joint funding from both the Army and the Marines, all PLRS field units transmit their data to a central PLRS system; a single Mifass system can then be connected with the PLRS center over wire or radio links, and can broadcast the data to other Mifass centers. The data is updated every one to two minutes for infantrymen and every one to two seconds for aircraft.

Mifass processes requests for fire from forward observers, who transmit their requests over standard field radios using a menu-driven hand-held digital terminal. Developed by Norden, the terminal is preprogrammed with a few messages, such as requests for fire, into which the soldier need only insert target coordinates. The user can read his message or those received from the Mifass center on the terminal's small display. When Mifass receives a request for fire, it calculates in real time which artillery batteries should open fire and what trajectories they should use, based on position, weather, and other data. The Mifass operator can then issue a fire command.

The heart of the system is the Dynamic Situation Display, a 12-by-16-in. plasma display panel. The high-resolution display is surrounded with light-emitting diodes and photodiodes that allow the operator to make decisions and request data by touching the screen with his finger. When the LEDs' light beams are broken, the terminal creates a cursor above the operator's fingertip,



SMART MAP. A map is placed behind a transparent plasma display in Norden's fire and air-support system. The screen shows locations of a battalion's forces.

which can be guided to a precise location on the map.

The top portion of the transparent flat-panel display features a slot into which operators place a map. The display then appears as a red overlay grid of coordinates over a 12-by-12-in. portion of the map, with the precise positions of all friendly forces and the estimated positions of enemy forces indicated.

When programming the display terminal, the operator enters the scale of map and, using the touch-screen capability, adjusts the grid coordinates of the display to line up with those on the map. With the flick of a single switch, he can zero in on particular areas and enlarge them up to a 1 : 1,000 scale on the display. This sacrifices the matching relationship between screen and map, but allows the operator to see more clearly what is going on in a small area. Conversely, he can expand the displayed field up to a scale of 1 : 250,000 to watch, for example, an aircraft leave the region he is studying.

The Fire Direction/Survey Calculator, a stand-alone unit with its own dedicated 16-bit microprocessor, also has a touch-sensitive plasma display. The menu-driven unit performs ballistic computations and land-surveying functions to determine artillery trajectories.

Powered either by a field generator or by the supply of a C-130 transport plane for air-based missions, the modular system is built around Control Data Corp.'s A-14 16-bit microcomputer, a standard Navy item. In addition to the computer and power units, a standard Mifass setup includes a fire-direction survey calculator, two printers, facilities for both analog and digital communications, the remote communications terminals, a memory module, a magnetic-tape drive, and up to 10 of the plasma Dynamic Situation Displays.

Each center would have two to four memory modules, which use CMOS static RAMs to store up to 1 million 16-bit words. In larger configurations, the system is backed up by the tape drive, which has identical capacity and is the only unit in the system that is not fully redundant, according to the company. *–Tobias Naegele*

SPACE

TESTING SPACE PROCESSING ON GROUND

CLEVELAND

As part of its drive to encourage more U. S. companies to get involved in research aimed at commercial production of materials in space, the National Aeronautics and Space Administration is opening the doors to a new $2.5 million laboratory at the NASA Lewis Research Center in Cleveland. An early focus of the lab will be to develop baseline information for growing semiconductor crystals in space.

Space processing holds particular promise for commercial production of extremely pure semiconductor materials [*Electronics,* Jan. 26, 1984, p. 89, and *ElectronicsWeek,* June 3, 1984, p. 42]. One major reason is that a microgravity (commonly called zero gravity) environment can significantly reduce convection currents caused mainly by gravity. These currents can swirl molten materials on earth, resulting in uneven distribution of dopants.

The Microgravity Materials Science Laboratory will be available for use at no charge to U. S. industrial, university, or government researchers who come up with acceptable ideas for experiments involving low-gravity materials processing. Depending on their data-processing requirements, researchers using the lab may obtain access to the NASA Lewis Cray 1-S/2000 supercomputer or one of three other mainframes.

"As long as researchers are willing to publish results in the open scientific literature within two years, this thing is going to be free," says Hugh R. Gray, chief of the metalic-materials branch at NASA Lewis's Materials Division. Companies that want to keep results proprietary will have to pay a fee for their use of the laboratory.

New NASA lab offers free help to experimenters

"The microgravity laboratory will provide an excellent starting point for ground-based research that will eventually be translated into orbital research and development," notes an official at 3M Co. The St. Paul, Minn., company is getting heavily involved in space-based research.

Microgravity-lab officials are soliciting proposals for ground-based experiments involving processes that could benefit from a microgravity environment. The idea is to establish a scientific baseline on the role of gravity in a particular experiment and identify those with the greatest potential for further development in space.

The only facility of its kind, the microgravity materials lab contains equipment that functionally duplicates gear on the U. S. space shuttle. For example, a General Purpose Furnace simulates functions of the furnace on the space shuttle. The furnace has already been used for experiments in processing gallium arsenide and other types of crystals in space.

DROP IT. One way to defeat gravity for brief intervals on earth is with vacuum-pumped drop tubes or drop towers, which can be used to subject an experiment to a brief period of low-gravity free-fall. Though most equipment in the microgravity lab is designed to provide baseline data in a 1-g environment, the laboratory apparatus includes an Instrumented Drop Tube that can provide 1 second of weightlessness. For experiments that need more time, NASA Lewis operates 30- and 145-meter drop towers, which can provide 2.2 and 5 s of free-fall, respectively.

Though these drop towers are not part of the microgravity lab, they may also be made available to visiting researchers who need to use them, NASA says. The same goes for use of the NASA Lewis Lear Jet, which can be flown through a parabolic trajectory to achieve a microgravity environment in the plane for up to 22 s. A typical experiment might start by establishing a 1-g baseline in the lab, then proceed to the drop towers or jet, if necessary, to qualify the project for space flight.

Most instrumentation in the microgravity lab is provided with data-logging units controlled by Hewlett-Packard Co. 85B microcomputers. Recorded data can be transferred for further analysis to one of several computers in the lab. For the most demanding types of analysis or modeling, the lab's machines are linked to four large computers—including the Cray—in the NASA Lewis Research Analysis Center.

In addition to work with semiconductor crystals, the laboratory's initial capabilities also support experiments that involve metal and alloy solidification, NASA says. Additional equipment for work with other materials including glasses, ceramics, and polymers will be brought on line in the future.

Experiments would set scientific baselines on role of gravity

Funding for the microgravity laboratory comes from the Microgravity Science and Applications Division of NASA's Office of Space Science and Applications at the agency's headquarters in Washington. *–Wesley R. Iversen*

SPACE STATION MAY AUTOMATE TO SAVE MONEY

WASHINGTON

The nation's first manned space station, which should be orbiting the earth by 1992, could depend a lot more on machines than originally planned. The National Aeronautics and Space Administration is planning to increase the level of automation, hoping to raise the station's productivity and reduce its operating costs.

Preliminary goals call for both fully automated and manned systems enhanced by expert systems (for more on NASA's big push in artificial intelligence, see p. 32). Fully automated controllers would handle the basic control, electrical power, guidance, and navigation functions. Manned systems would handle communications and tracking as well as information and data management. Among the benefits automation is intended to provide are improved productivity, flexibility, efficiency, and reliability.

The impetus for designing machine intelligence into the permanently manned space station stems mainly from legislation approved last year establishing an Advanced Technology Advisory Committee within NASA. The committee is charged with identifying space-station systems ripe for automation.

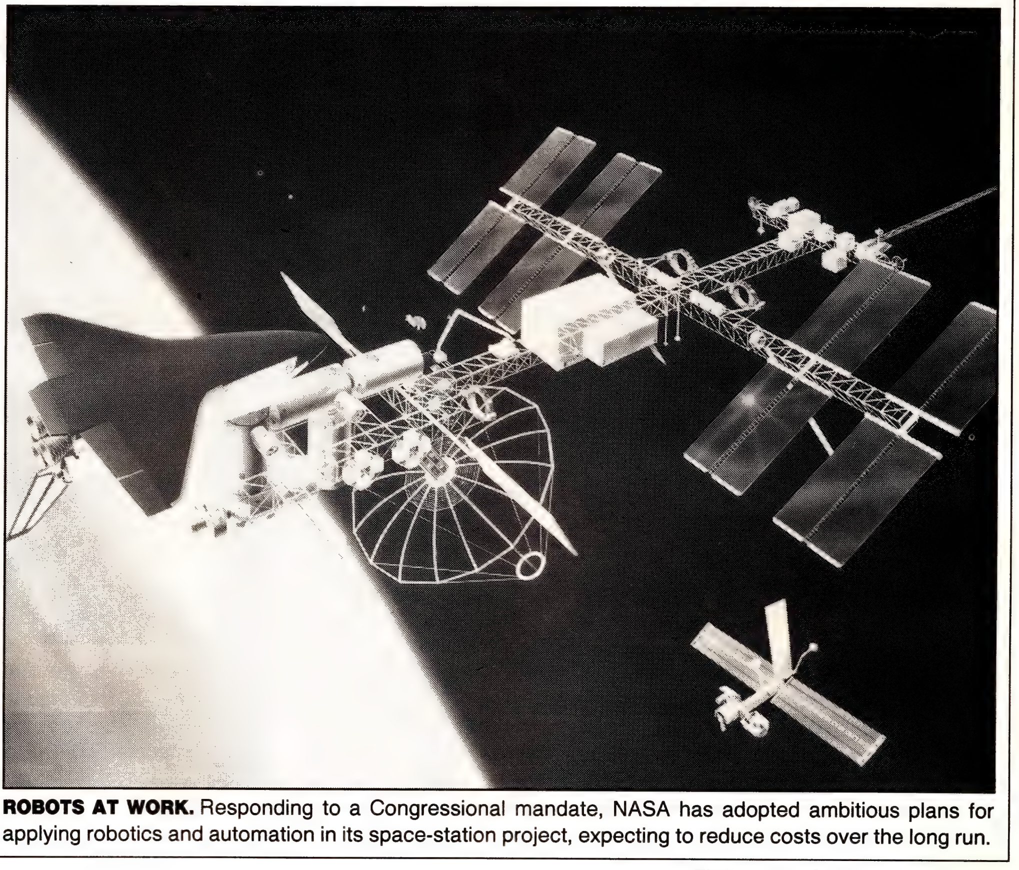
In a report issued this spring, the committee called for extensive use of advanced general-purpose automation, robotics, and AI technology aimed at developing computer vision, expert systems, and high-precision robot arms.

"The initial space station should be designed to accommodate future evolution and growth in automation and robotics," explained Aaron Cohen, chairman of the advisory committee, during an early September symposium in Washington on space-station automation. Cohen, director of research and engineering at NASA's Johnson Space Center, Houston, emphasized the need for further research in sensors and software systems.

HUMAN ELEMENT. No one disputes the fact that machines are far cheaper to keep in space than human beings. Still, Cohen and NASA administrator James M. Beggs seem reluctant to endorse a fully automated space station. Citing examples from previous manned missions where human intervention was needed to solve complex problems, Beggs argued at the symposium that "it has been a mix of man and machine that has made the space program successful." Increasing human productivity through automation would be the biggest challenge of the three-year-old space-station program, Beggs says.

Currently scheduled for launch in 1992, the first space station is now midway through its second design phase. This definition and preliminary-design phase is expected to be completed in January 1987. NASA estimates that a mature space station will be launched by the year 2010.

NASA estimated two years ago that development of the initial space station would cost $8 billion, but Beggs says the agency would need a 7% to 13% funding increase to completely embrace automation technology. Whether such funds will be forthcoming is unclear, but Richard N. Malow, a House Appro-



ROBOTS AT WORK. Responding to a Congressional mandate, NASA has adopted ambitious plans for applying robotics and automation in its space-station project, expecting to reduce costs over the long run.

priations Committee staff member, says the possibility is very good.

"The bottom line is that the Congress views automation and robotics as very important to the space program and manufacturing on earth," says Malow. Moreover, he adds, cost-reducing automation could be a necessity if budget cuts are made in the space program.

DYNAMIC TENSION. Nevertheless, Malow identifies what he calls a dynamic tension between technologists seeking to integrate automation into the space program and managers in the space-station program more interested in the success of the mission. "It's going to benefit everyone, including NASA, to move from manual modes to some form of automation in order to bring down rising operational costs," he contends.

Since it was directed to commit up to 10% of its space-station budget to automation, NASA, along with five contractors, has investigated the potential uses of automation in selected space-station subsystems. Funded studies include those from Martin Marietta Corp., looking at autonomous systems and assembly; Hughes Aircraft Co., working on mission ground support; General Electric Co.'s Space Systems Division, focusing on space manufacturing, particularly on production of gallium arsenide crystals and wafer fabrication; and TRW Inc.'s Space and Technology Group, studying satellite servicing. Boeing Aerospace Co. funded its own study on the operator-systems interface.

Automation might be necessary to satisfy a frugal Congress

Current work on the space station is building on the five studies, according to Jon D. Erickson, manager of NASA's Artificial Intelligence and Information Sciences Office at the Johnson Space Center. "The good news is that we have a large number of options," Erickson told the audience at the space-station symposium. "The bad news is that they probably won't all make it into the original station."

But that may not be the end of the story. In addition, the space station could serve as a test bed for the development of general-purpose automation technologies that could find their way to the factory floor, other government officials say. *–George Leopold*

COMPUTER-AIDED DESIGN

AI SHOWS THE WAY IN CHIP WIRING

KAWASAKI, JAPAN

NEC Corp. has joined a select group of companies—which includes Nippon Telegraph & Telephone, Schlumberger, and The Carnegie Group—working on the application of artificial-intelligence techniques to computer-aided design. NEC developed its experimental interactive routing system, dubbed Wirex, to spare designers the tricky, time-consuming task of finishing up the connection paths among the thousands of devices on very large-scale integrated circuits.

Motivated by the fact that the chip-designer population isn't growing fast enough to meet the demand for new and larger chips, a group led by Hajimu Mori at NEC's C&C Systems Research Laboratories at Kawasaki developed the Wirex system as a way around the bottleneck. Wirex incorporates the expertise needed to lead an inexperienced person through the steps needed to complete the wiring of VLSI chips. In fact, a neophyte guided by Wirex can do the job faster than an expert working on the graphic display of a conventional CAD system.

OUTDOING COMPUTERS. Experienced designers have an edge over computers in completing designs because they have an intuitive ability to reach a goal. The designer's knowledge specifies an operation for each specific situation, which is represented as design objects, their properties, and the logical relation among them.

Wirex expresses this knowledge in rules written in Prolog, a language developed for AI, and stored in a knowledge base. The Prolog program makes inferences based on the rules to perform the layout design. Rules written in Prolog can also be changed or supplemented far more easily than rules written in a procedural language.

Unfortunately, Prolog's voracious appetite for memory and its slow execution speed when run on a conventional computer make it impractical for an LSI CAD system. So Mori's group adopted a hybrid approach to software implementation, combining Prolog code for its convenience in knowledge-base programming with code written in Fortran, which makes for faster execution and better memory utilization on a conventional computer.

An added benefit is that Wirex can tap an already-large data base for CAD systems in Fortran. The hybrid software thus runs comfortably on a NEC/MS minicomputer with up to 16 megabytes of main memory, 200 megabytes of hard-disk capacity, and a 2,048-by-2,048-pixel display.

The Fortran CAD data base contains physical information about the design objectives. The rules written in Prolog are represented as a sequence of predicates, which are functions that test for various conditions. They are actually external functional predicates: they correspond to Fortran functions in the external CAD system to provide a linkage to that system.

Thus the rules written in Prolog call routines written in Fortran that actually manipulate the physical data in the CAD data base. The Prolog interpreter receives the result after execution of the Fortran subroutine.

To handle the several connections left uncompleted by an automatic router, an

MAKING CONNECTIONS. By pushing Yes and No buttons on the Wirex control panel, an inexperienced user can complete connections on a very large-scale-integration design.

experienced designer using a conventional CAD system will devise a strategy to complete a net connection, pin-pair by pin pair. The order is very important because unconnected pin pairs impact each other; this is one reason that the conventional deterministic automatic router is not completely successful.

It is at this point that Wirex implements the rules in its knowledge base. The system could decide to start with the pin pairs furthest apart, or it could disconnect an already connected net and start with another.

For example, it could disconnect a wire that blocks another by taking a route closely around one terminal of the blocked pin pair. Then after completing this connection, it will still be able to find an alternate route for the temporarily disconnected pin pair.

AVOIDING DETOURS. Other rules in the Wirex knowledge base deal with bottlenecks caused by local wiring congestion and rules for pattern improvement, including the elimination of unnecessary detours. The proper rule is highly dependent on the individual situation. In the knowledge-base system, the rules or design strategies selected can vary adaptively; this is the major advantage over conventional CAD systems.

Pushing a Yes or No button to solve a dopant problem

The system currently has 44 rules to solve blocking problems near signal pins, 42 rules to solve blocking problems near channel bottlenecks, and 15 rules to improve pattern shapes. There are also 61 rules to determine which rule is most suitable in each situation, and 103 rules for system control.

Wirex has demonstrated its Prolog smarts impressively. For example, on an LSI 2,100-gate array with 2,140 signal pins requiring connections, 12 connections could not be completed by an automatic router. The net was completed within a half hour by a nonexpert, who merely pushed the Yes or No button on the Wirex to indicate whether the strategy or rule provided by the system was acceptable.

No further graphic operation was necessary. The same problem took an expert designer at a conventional completely interactive CAD terminal more than one hour.

The research was supported by Japan's Institute for New Generation Computer Technology, which is also the group coordinating the Fifth Generation Computer Systems Project for the Japanese Ministry of International Trade and Industry. *–Charles L. Cohen*

PACKAGING

SOLDER COLUMNS SECURE CHIP CARRIERS TO EPOXY

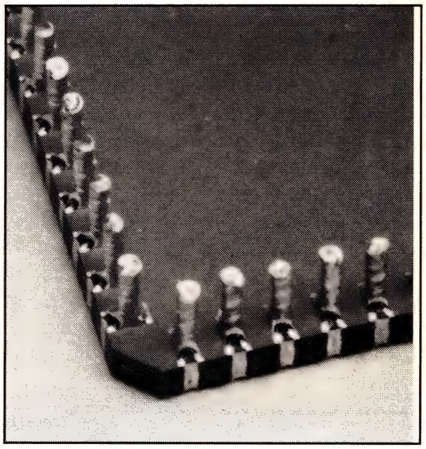
MENLO PARK, CALIF.

For years, engineers have tried and failed to marry leadless chip carriers with inexpensive epoxy-glass boards. Because of the thermal mismatch between the two, solder joints between the carrier and the board crack. As a result, engineers have had to rely on board materials costing as much as 10 times more than epoxy-glass boards to take advantage of leadless chip carriers. Now Raychem Corp. could have the answer. It has gone into pilot production of a unique chip-carrier mounting device—a disposable frame containing solder columns that in tests have withstood hundreds of thermal cycles without failing.

Previously, this kind of performance could be had only by using such board materials as Kevlar polyimide and copper invar copper that are tailored to match the thermal coefficient of expansion of the carrier's alumina body.

The company ran extensive thermal-cycling tests last month on more than 300 samples of 68-input/output leadless ceramic chip carriers mounted by compliant solder columns to epoxy-glass boards. The solder joints of these boards can survive 18 to 35 times more temperature cycles than can joints of conventionally soldered epoxy-glass boards.

The mounting device consists of a foam frame with solder columns 100 mils high and 22 mils in diameter embedded on 50-mil centers. Raychem exhibited a working prototype at Nepcon East in June 1984 [*Electronics*, June 28, 1984, p. 54]. These early units survived more than 1,000 cycles from –55°C to +125°C without solder-joint failures. Their assembly, however, made it difficult to line up the solder columns. The first step called for the frame to be aligned to the solder pads of the board; then the chip carrier was mated to the columns of the frame. This assembly was reflow soldered to the board.



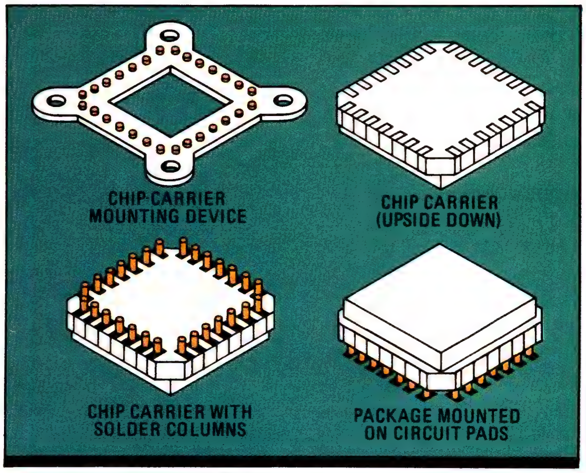
PROPER ALIGNMENT. Fitting on top of a leadless ceramic chip carrier, a foam holder ensures proper alignment of the solder columns, and is then washed away.

The original process also caused a disposal problem, since a toxic methylene chloride solvent was needed to dissolve the polysulfone holder after soldering.

WATER-SOLUBLE. Raychem's latest units have a new, water-soluble holder. In addition, the company has come up with a mounting procedure that makes it easier to line up the items on a board.

In the new mounting procedure, the chip-carrier mounting device is joined with the carrier in a pressure-plate/template fixture and is reflowed (see diagram). During reflow, the columns are compressed slightly to force the free ends (feet) to be highly coplanar. Then the foam holder is washed off. Finally, the carrier on its solder columns is reflow soldered in either a vapor-phase, infrared, or hot-air oven.

In the most recent thermal-cycling tests, the company used three groups of identical 68-I/O carriers. One group had carriers mounted with 100-mil-high solder columns; the second had carriers mounted with 50-mil-high solder columns, designed for low-profile applications. The control group consist-


CHIP-CARRIER MOUNTING DEVICE
CHIP CARRIER (UPSIDE DOWN)
CHIP CARRIER WITH SOLDER COLUMNS
PACKAGE MOUNTED ON CIRCUIT PADS

COMPLIANT COLUMNS. Compliant, reinforced solder columns are attached to a leadless ceramic chip carrier by placing a foam holder on top of it and then reflow soldering.

ed of conventionally soldered carriers.

All groups used the same type 1/16-in. double-sided epoxy-glass board. Test equipment and conditions met MIL-STD 883, method 1010.5, condition B: the thermal cycle was –55°C to +125°C with a 15-minute dwell at each extreme.

The solder columns dramatically improved endurance. Directly mounted assemblies failed for the first time at less than 50 cycles. First failure for the 50-mil-high columns came at about 800 cycles; the 100-mil-high columns failed first at about 1,300 cycles. The average number of failures for the 50-mil columns occurred after 1,272 cycles; the same number of failures for the 100-mil columns occurred after 1,705 cycles.

To test the integrity of the solder columns after thermal cycling, a number of mechanical abuse tests (vibration and shock) were applied sequentially to an assembly after it had already undergone 500 thermal cycles. The average column resistance (about 7 mΩ) was unaffected by this mechanical testing.

Besides the 50-mil-center applications, Raychem is developing a narrower, shorter solder column for carriers on 40-mil centers. Use of the foam holder could extend beyond chip-carrier applications. Raychem "is seeing a growing interest in the use of CCMDs for mounting-pad grid arrays"—a ceramic package with a grid of pads on its mounting side, says Ray Noel, leader of the Microelectronics Interconnect Group. The mounting devices would make it easier to clean and inspect the array's solder joints, which is difficult with directly mounted arrays. *–Jerry Lyman*

Disposable lead frames withstand hundreds of thermal cycles

IC PRODUCTION

SPUTTERER COVERS STEEP WALLS EVENLY

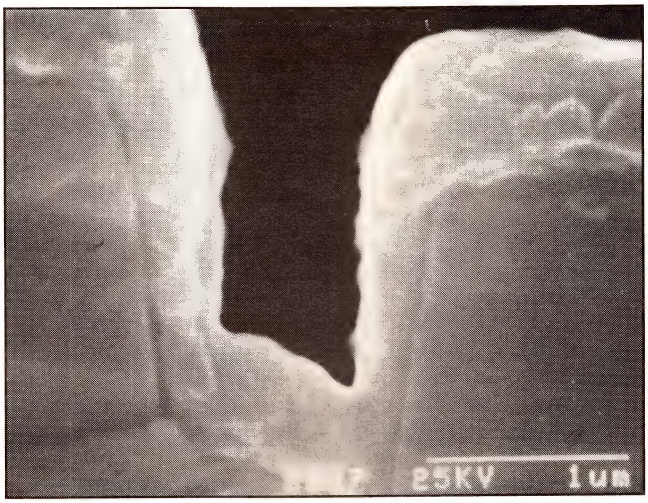
PARSIPPANY, N. J.

Systems for sputtering thin metal films onto wafers have usually had trouble getting even coverage of the steep walls of the features inherent to small-device geometries.

Now a newcomer to the field, Machine Technology Inc., claims to have licked the problem with a machine that produces continuous, crack-free step coverage of at least 50% of surface thickness over an 8,500-Å-high step with 80°- to 90° slopes.

MTI officials assert the company's method for sputter-coating wafers up to 8 in. in diameter achieves results superior to anything its competitors have to offer. The Parsippany company says its Sypherline serial sputter-coating machines, which it will unveil this week at the Semicon East conference in Boston, provide the 50% step coverage on any geometry down to 2 μm, while guaranteeing ±4% thickness uniformity on both a series of wafers and across an individual wafer's surface.

The difficulty of coating steep device walls has led many manufacturers to heat the substrates, a method that does improve coverage—but at some expense. The technique yields a more uniform coating, but the grain size within the coating is likely to grow larger, leaving a pocked surface that makes etching far more difficult, says MTI. Though the company considers it unnecessary on the Sypherline machines, a wafer-heating option is available.



COVERED CLIFFS. A thin aluminum layer, evenly covering the steep walls of a narrow silicon-dioxide canyon, was fabricated by a new sputtering system from Machine Technology Inc.

The Sypher, a high-rate dc planar magnetron sputtering system, uses a vertical-processing or "sputter-sideways" scheme that suspends the wafer at a right angle to the process chamber floor, according to Lawrence Lamont, manager of engineering and development for the system. In conventional systems, the wafer is parallel to the floor. MTI utilizes a proprietary technique to achieve a high coating uniformity—within 2% across the surface of 5-in. or smaller wafers, says financial relations manager Bill Schneider.

MTI puts throughput for the highly modular, cassette-automated units at a competitive 45 wafers per hour when using the standard 15-kHz power supply, or up to 55 wafers/h with the optional 20-kHz supply. The company specifies a system-up time of 85%, including maintenance scheduled every 60 hours.

MULTIPLE CHAMBERS. Each system can be configured with up to four process chambers, each of which has its own cryogenic pump to produce a vacuum. The units' ability to maintain varying vacuum intensities allows the system to handle complex processes that demand different pressures at each stage, such as those for laying down titanium nitride. One chamber is usually used for radio-frequency sputter etching to clean wafer surfaces before film deposition. Up to three more dc-magnetron chambers can be added for applying films of up to three different metals.

The Sypher, which handles wafers one at a time, is built around a central transfer chamber. The air-tight system features load-locks at every intersection. To avoid contamination, individual wafers are never permitted to share the same open space within the machine. While the machine applies the coating, the wafer is suspended at the center of the process chamber to protect it from contaminating debris.

MTI addressed the issue of wafer cleanliness in two configurations, one for Class 10 clean rooms and another for Class 100. The Class 10 version takes up just 1 ft² of floor space in the clean room, while the Class 100 setup requires 5 ft². The system is fully automatic, with an operator programming the system's controller for each job with a light pen and menu-driven commands, the company says.

The Sypher can make the switch among 4-, 5-, 6-, and 8-in. wafers in 15 min. "That's unheard-of in systems that handle wafers automatically," Lamont claims.

It has been just one year since MTI agreed to bankroll the pair of engineers who thought they could build a sputter-coating system aimed at highly uniform aluminum, aluminum alloy, and silicide processes. Lamont and Tom Strahl, who head up the Sypher team at MTI's San Jose, Calif., facility, asked the company for $12,000 to start work. "We built this whole thing in one year for less than a million bucks," boasts Schneider. *–Tobias Naegele*

SEPTEMBER 16, 1985

ELECTRONICS WEEK

HOME COMPUTERS NOT DEAD YET

Despite the recent inactivity of major manufacturers, the home computer industry refuses to die. This is the latest position of Future Computing Inc., a Dallas market research company specializing in the personal computer industry.

Although the company has trimmed its estimate of 1985 unit sales—from 4.5 million units to 3.2 million—it says that manufacturers can still expect a significant second half this year. Future Computing says it reduced its expectations because of the sharp decrease in sales of low-end (under $1,000) products and results of a recent survey of end users.

HYBRIDS USE MORE EXOTIC MATERIALS

Although alumina ceramic is still the most widely used substrate material for hybrid circuits, there is a growing trend toward esoteric materials, according to a report by DBA Inc., a Fort Washington, Pa., engineering and consulting company.

Polyimide, which is usually associated with the manufacture of printed-circuit boards, is used as a substrate by 23% of the manufacturers of hybrid circuits in the DBA survey. Another 17% use metal-core substrates, a specialized material that is used for chip capacitors and other high-temperature applications.

Not surprisingly, use of alumina and beryllia, the traditional ceramics used for hybrid substrates, was reported by 98% and 45% of the manufacturers, respectively.

ADAPSO FILES BRIEF IN COPYRIGHT SUIT

The Association of Data Processing Service Organizations has filed a friend of the court brief in a case that could define how much of a computer program can be copyrighted. The defendant in the case of *Whelan Associates Inc.* v. *Jaslow Dental Laboratory Inc.*, now pending before the U. S. Court of Appeals in Philadelphia, contends that only the text of the program, in either object or source code, is protected.

Whelan and Adapso say that Jaslow took the underlying logic stream of a program to manage a dental lab and merely did a translation. They argue that copyright protection extends beyond the literal code to encompass translations and even essentials of a program's organization and structure. The decision in the original case was in favor of Whelan.

BILLIONS AWARDED FOR B-1B

In some of the largest contracts offered in recent memory, the U. S. Air Force's Aeronautical Systems Division, Wright-Patterson Air Force Base has awarded more than $11 billion in the B-1B supersonic bomber program. Rockwell International Corp. will receive $8 billion for the final 82 aircraft; Eaton Corp. AIL Division's 92 units of defensive avionics equipment amounted to an $1.8 billion contract; and Boeing Military Airplane Co. received a $953 million contract covering 82 units of offensive avionics.

DIGITAL SWITCH MAKES JAPAN SALE

Efforts to open the Japanese telephone market to U. S. companies have resulted in a potentially sizable equipment contract for a Richardson, Texas, switch maker. Digital Switch Corp. says that it will supply telecommunications equipment to Daini-Denden Inc., Tokyo, which has been formed by 225 Japanese companies to provide nationwide long-distance services. The new outfit has received Japanese government approval to compete with Nippon Telegraph & Telephone Corp.

Daini-Denden plans to start private network services at the end of next year and switched communications at the beginning of 1987.

The purchase contract, which has an initial value of $10 million to $20 million, calls for Digital Switch to install four DEX 600 switching systems and a network control center.

Digital Switch officials believe the deal is further evidence that U. S. companies are making greater inroads into once-restricted Japanese electronics markets.

EXOTIC-MATERIALS LAB BEING BUILT

A $1.7 million facility being built at Los Alamos National Laboratory, in New Mexico, will use ion beams to research innovative metals, alloys, and ceramics with exotic properties that are not found in nature. The Ion Beam Materials Research and Technology Laboratory will have an ion implanter and a 3-MV accelerator.

The ion implanter will be operating within a few months, the accelerator in about a year. There will be seven beam lines—five for analysis, two for ion implantation—for use in a wide range of research, including defense, energy, semiconductor, and other technologies.

THREE VENDORS ADOPT SUN SYSTEM

Sun Microsystems Inc. has signed up three more vendors in its drive to promote its Network File System as a standard for exchanging files among different systems. The three are computer makers Celerity Computing, San Diego, which designs Unix-based 32-bit systems for engineering and scientific applications; Sequent Computer Systems Inc., Portland, Ore., which will support the Sun file facilities on its Balance 8000 system; and Lachman Associates Inc., a Westmont, Ill., software house. Lachman specializes in Unix software and plans to develop the Network File System for Unix V.

AT&T IN PRIVATE-LABEL PACT

Digital Microwave Corp. has signed a multiyear multimillion-dollar private-label contract under which the small Santa Clara, Calif., company will provide short-haul transmission equipment to AT&T Co. The product, a 23-GHz microwave radio called the AT&T DR23, will be used to connect computers, private-branch-exchange equipment, data terminals, and local networks over distances of up to 10 miles.

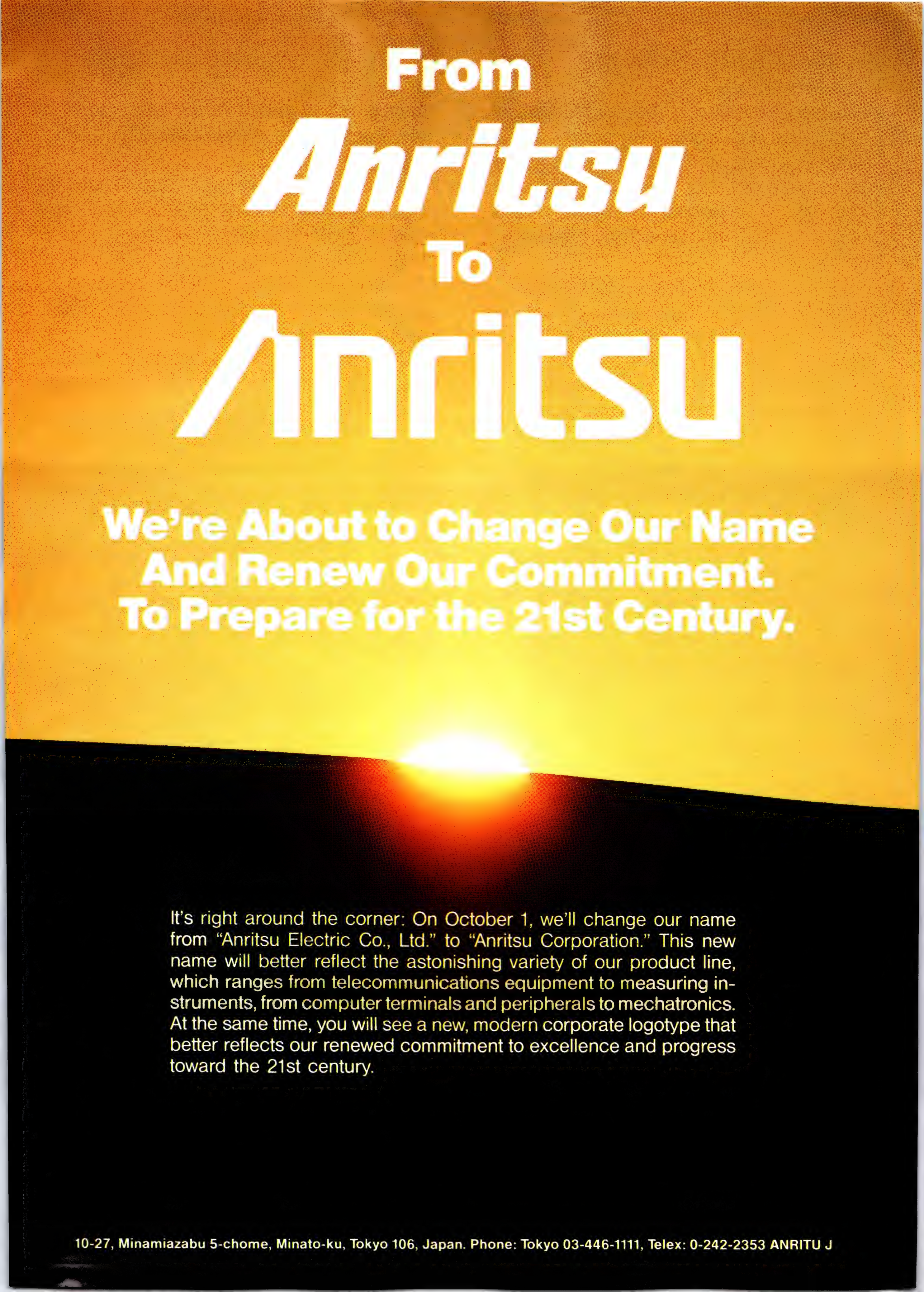
NAS, KOREANS SIGN DEAL

National Advanced Systems, a Mountain View, Calif., subsidiary of National Semiconductor Corp., has formed a company with a Korean outfit—Hyosung Corp., Seoul. The new company, Hyosung-NAS, will distribute NAS data-processing equipment in Korea. Its first customer is the Government of Korea, which purchased an AS/8083 system for the Korea Advanced Institute of Science and Technology.

Hyosung is a $2 billion diversified manufacturing company turning out products that range from heavy industrial equipment to data-processing equipment.

IBM BUILDS SMALL TUNNELING SCOPE

IBM Corp. scientists in Zurich have built a scanning tunneling microscope with a scanning assembly small enough to be held in one hand. Tunneling microscopes, invented by IBM in 1981, can show how individual atoms are arranged on the surface of materials. The company is using it in research on computer circuitry.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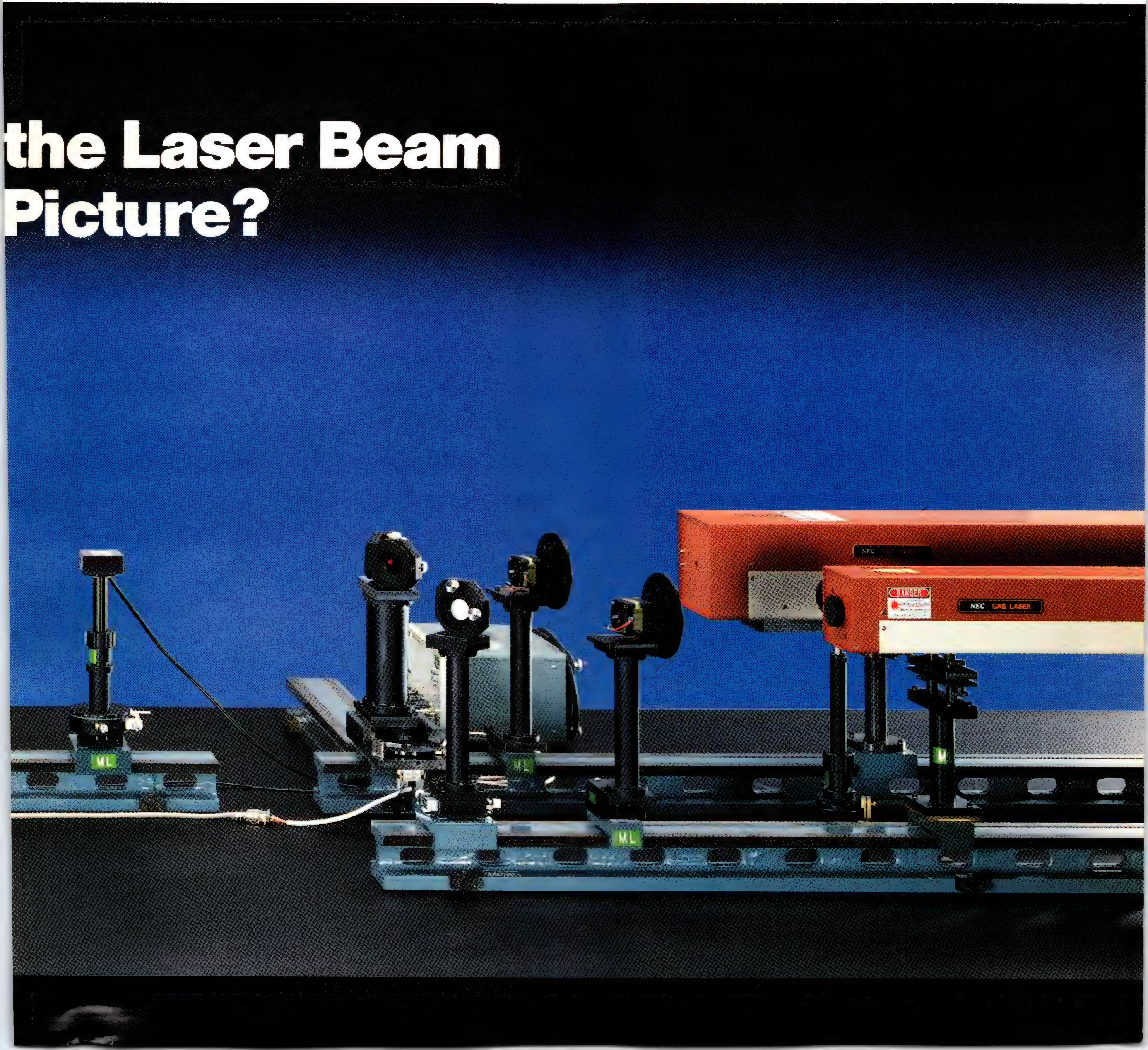


the Laser Beam Picture?

OPTICAL STORAGE: HOT ITEM OR A DUD?

SOME SAY CDROM WILL SAVE THE HOME COMPUTER

by Denise Caruso

PALO ALTO

Optical disk drives, "disguised" as high-fidelity stereo equipment, have already encouraged music enthusiasts to purchase some 2 million compact-disk players. Within the next few months, nearly a dozen companies worldwide will introduce very similar compact-disk drives, adapted for a new role: as personal computer peripherals that can access more than 550 megabytes of virtually indestructible data, permanently recorded by laser on a single 20,000-track 5-in. platter.

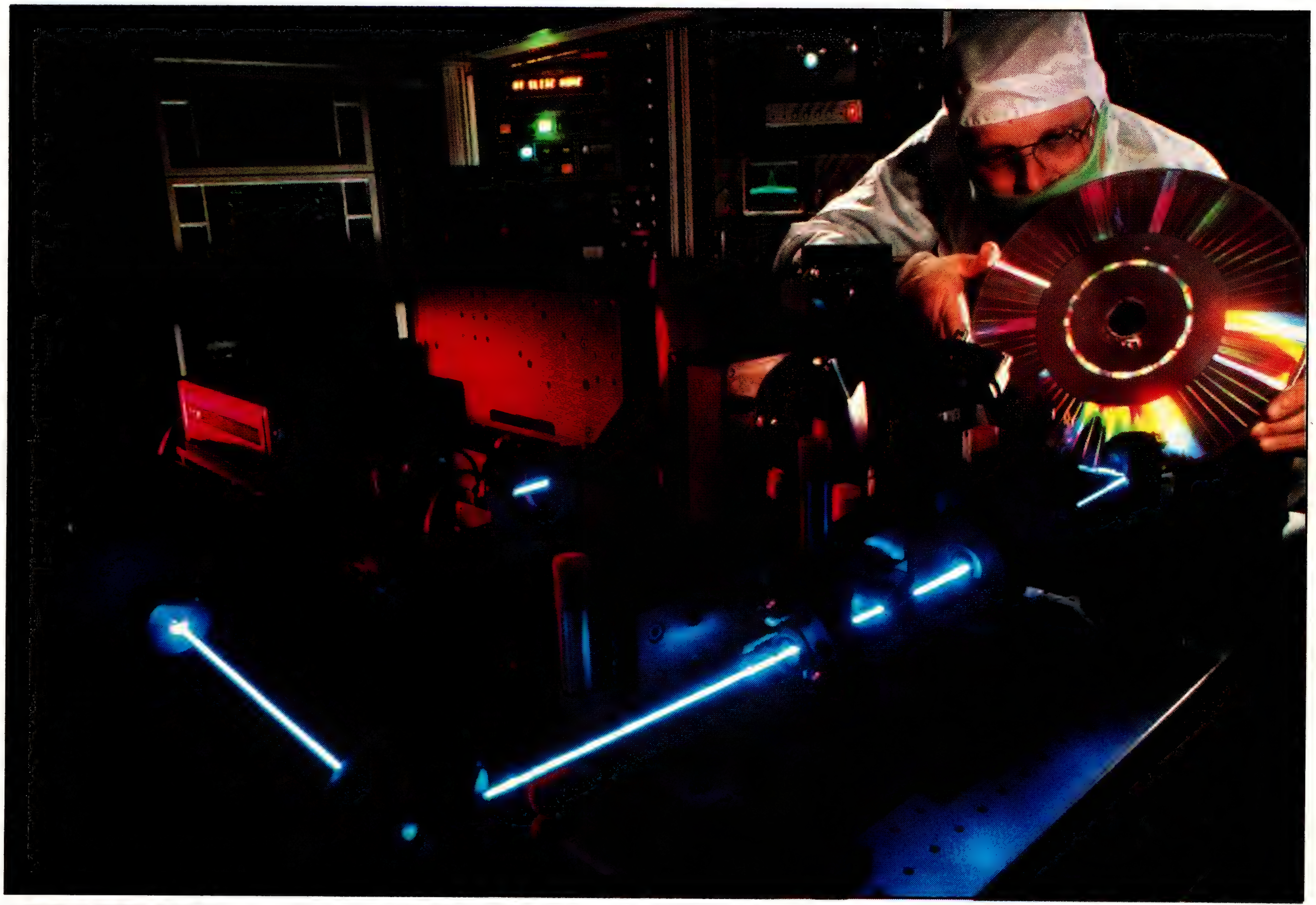
Some observers say the new peripheral is the application that will save the home computer. But marketers face the classic three-pronged problem: convincing consumers that they need one, getting enough programming to do the convincing, and establishing software and hardware standards.

In the sluggish sales world of personal computers, manufacturers are watching to see if Atari Corp.'s CDROM (compact-disk read-only memory) player actually helps sell the company's new 520ST computer. The player, claims Atari, will cost under $500 and will be shipped with a compact-disk version of the Grolier Academic American Encyclopedia, which will cost another $200 including software. A printed set of volumes costs between $450 and $650.

Meanwhile, the cost of audio disks and players is plummeting—Sony Corp. recently introduced a portable model for less than $300—and some industry watchers say that trend will establish CDROM readers as a blockbuster peripheral that will revive the languishing home computer market.

The idea is that disks such as the Grolier encyclopedia, equipped with powerful search-and-retrieval software, will provide an irresistible reason to buy a personal computer. Despite the fact that Future Computing Inc. of Dallas has already revised its estimates for 1985 U. S. personal computer sales downward once this year—from 4.3 million to 3.2 million—chairman Egil Juliussen contends that consumers still want to buy personal computers for home use. And CDROM enthusiasts think many buyers will want optical-storage drives—either CDROMs or write-once versions.

Among those enthusiasts is Edward Rothchild of Rothchild Consultants in



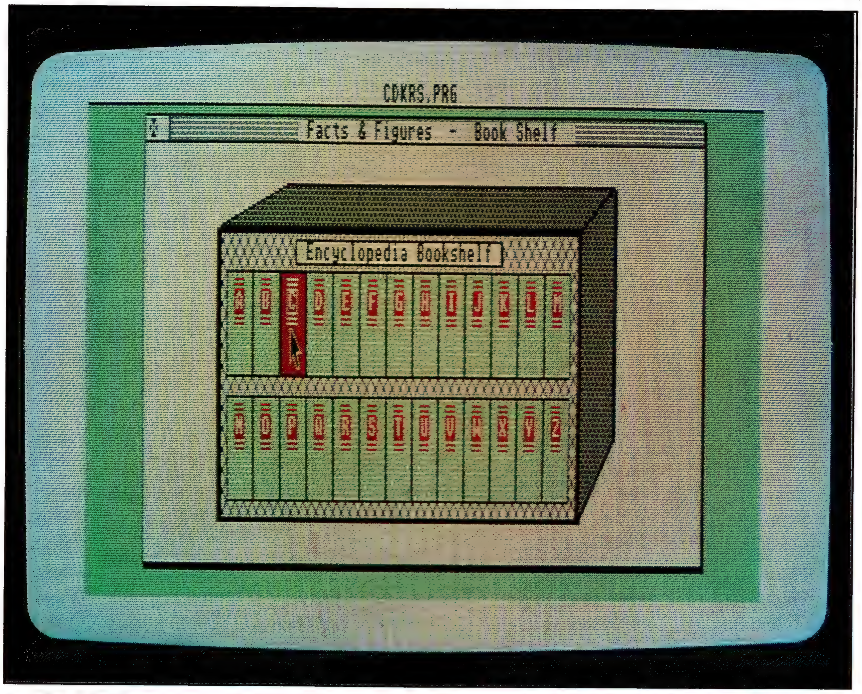
TURNING THEM OUT. Disks are mastered at 3M Co. facility from premastering data bases prepared in CDROM format on 9-track magnetic tape.

San Francisco. "It could definitely revitalize the home computer market," he claims. A market researcher and champion of the optical industry, Rothchild believes that by 1990 as many as 3 million write-once drives could be installed in the office-automation market.

Another market watcher, Freeman Associates, compiled the first detailed projection of optical-storage markets last year. Raymond C. Freeman, head of the Santa Barbara, Calif., company, is already working on an upward revision of his own CDROM projections, which he had put previously at 2.4 million by 1990.

"Toward the end of the decade, the markets will segment, and CDROMs will be lower-priced as primarily a consumer product," consultant Rothchild says. "That's when electronic publishing will really take off. Publications, traditionally in print, will be on a disk with text, graphics, data, audio, and still-frame video on the same disk. It will attract new information publishers who don't have a vested interest in the print medium. This in turn will force traditional information providers into using CDROM."

Certainly, not everyone is hopping on the CD bandwagon. Some analysts suggest that it might turn out to be just another product. "The [Grolier] encyclopedia is a flash in the pan," claims James Porter, president of Disk/Trend Inc., a market research company that follows the disk-drive industry. "They're hitting the market with a pillow." Yet, Porter admits, there are many applications for the technology, especially for entities with significant data bases that want to convert and publish them in that format. But he cautions that a market for the technology doesn't exist yet, and even by 1990 CDROMs will penetrate no more than 5% to 10% of personal computers in the workplace.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SALES AID. Atari hopes Grolier Encyclopedia in CDROM will help sell its 520ST computer.

Even Porter's estimate is high for the next five years. "All the numbers I've heard seem high to me," says Jan Lewis, president of Palo Alto Research Group. "But the curve of going from a real innovator technology to where it achieves mass-market penetration could be fairly quick once it starts, and I figure it will start in a couple of years. A mass-market product, however, is a few years away."

Lewis sees the early move by Atari as a way to "put a little life in its product offerings, basically to get some attention." But, she adds, until there's some "real content" on CDROM disks, "it's nothing more than a gimmick—although in the long term, the technology will be significant in both the home and business market."

Prospects are hazy near-term, but look bright over long run

Most computer companies tend to agree. Apple Computer Inc. and IBM Corp. are believed to be talking to CDROM manufacturers about developing interfaces for their personal computers, although IBM flatly denies it and Apple will only say the project is "not on a front burner." A spokesman at Commodore International Ltd. says the company had "worked with Grolier." Even Grolier is cagey: "Let's just say we plan to be available for almost every vendor" is the only comment a spokesman would make.

But over the longer run, equipment suppliers are betting that optical-memory technology will make it big in the personal-computer world. Two basic products—CDROMs and direct-read-after-write, or DRAWs—are already being touted as existing or planned by manufacturers. More CDROM readers may initially reach market (although two DRAW companies are presently shipping compact drives).

CDROM players are essentially souped-up versions of the CD audio players, minus audio-control panels and plus extra error-correction facilities. DRAW readers are more complicated, since they require far more complex error-cor-rection techniques.

Most drive companies create their own glass "mother" disks from standard nine-track magnetic tape. Philips in the Netherlands is probably the most advanced in this area and is working with Sony to pioneer format standards for CDROM technology.

Most CDROM drives are being built in Japan, as are most CD audio players. Another source is Philips, which is shipping production quantities of its CDROM units. In Japan, Sony is shipping to original-equipment manufacturers in small quantities. Other announcements by Hitachi, Toshiba, Matsushita Electric (sold under the Panasonic label) and Nippon Columbia (sold under the Denon label) are expected by year-end or mid-1986. None is announcing prices, but given Atari's "under $500" dictum, the cost to consumers is expected to be in that range.

Some U. S. companies, such as Reference Technology Inc., of Boulder, Colo., have shrunk the large-format optical-storage technology that is already making a mark in the world of larger computers down to the CDROM format and added cables and controller cards. When the consumer market opens up, they expect to be ready to sally forth.

CDROM manufacturers are trying to make the transition from print to disk easier. Some have been built to the size of a standard, 5¼-in. half-height floppy-disk drive, thereby making design-in easier for engineers.

Generally, their data-transfer rate is more than twice that of floppy drives, or around 175,000 bytes a second. Bit-error rates average 10^{-12} after error correction, the same as with both floppy and hard disks.

A drawback to CDROM readers is their slow access time. During a seek, the diode laser must look at thousands more tracks than it would on a floppy or hard disk. Random searches usually take from 1 to 3 seconds, compared to an average 365 ms for a floppy disk. Manufacturers are telling potential customers that a second generation of CDROM readers will shave access time to as little as 200 ms by boosting servo speeds and adding error correction and by developing software that uses such schemes as pipelining and buffering to compensate for the hardware's relative slowness.

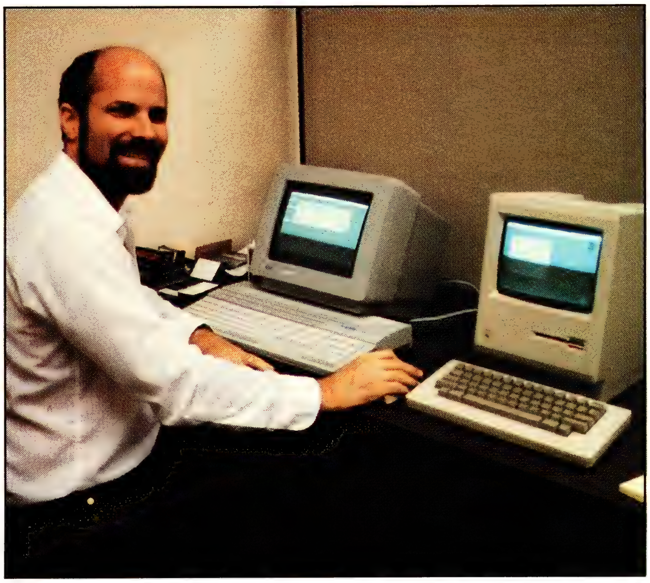
"It's very important how you lay data on the disk," claims Gary Kildall, president of Activenture Corp., of Pacific Grove, Calif., the company that pioneered search-and-retrieval software for personal computers hosting video disks and CDROMs. Kildall approached both Atari and Grolier Electronic Publishing to develop the 21-volume, 9-million-word encyclopedia.

A WORD MONSTER. Activenture's software, called Knowledge Retrieval System for the IBM Personal Computer and Facts & Figures for the Atari 520 ST, can perform word searches on up to 40 words simultaneously, tell how many times the words appear in the entire encyclopedia, and guide users to references that contain the words in almost any configuration desired—in the same sentence, the same paragraph, the same article. Chief engineer Thomas Rolander says the most complicated search possible takes 15 seconds.

Kildall, also the chairman of Digital Research Inc., the personal-computer-software company that developed the Graphics Environment Manager operating system now being used on the Atari 520ST, is convinced that CDROMs will take off in the consumer market within a few months.

"Before January, we're staging for a real hit and we'll start seeing action in the first and second quarters of 1986," says Kildall confidently. "Atari will be bringing its product to market, and there will be lots of activity from other vendors as well."

Activenture is also a premastering house, which means it prepares data bases in CD format on 9-track tape to be sent off for mastering by such companies as 3M and Laserdata, which also manufacture optical media. Kildall vows to have 10 disk titles ready by January. "The first stage is to seed the market. We brought up one data base in four days, start to finish, taking in typesetting tapes with format commands," he claims. The new disks, he says, will be education-oriented in the same way as the Grolier encyclopedia, but he declines to name specific titles.


QUICK STUDY. Activenture's chief engineer Thomas Rolander says most complicated possible search of encyclopedia will take only 15 s.

Grolier Electronic Publishing in New York, a division of Grolier Inc. of Danbury, Conn., plans to market the disk encyclopedia in the markets in which it is already strong—homes, schools, and libraries—where a personal computer is likely already available and underutilized. Cole wouldn't comment about development costs for the disk-and-software system. But he points out that the costs of developing the retrieval software and restructuring the data for CDROMs are minor when compared to developing the encyclopedia itself. He claims that the job from start to finish, including developing the encyclopedia, would cost $25 million.

Commercial use of CDROMS may be even more significant

Perhaps more significant than consumer use will be commercial applications of CDROM. A plan similar to Grolier's has pushed Information Handling Services into the world of CDROM. The Englewood, Colo., company has a 10-million-page "vault" of information on military specifications, industry standards, products, and vendors that it provides to some 8,000 customers.

"CDROM is the first feasible technology to provide complete data bases to our clients" for immediate search and retrieval, says Patricia Wimberly, assistant director of electronic products for the company. The information that would fill 1,500 floppy disks or 220,000 pages will fit on one CD.

Information Handling Services will first sell a single CDROM disk containing all index information to all products in its massive data bases. Available in early 1986, it will point to microfilm or microfiche references and will sell with retrieval software for the IBM PC family and compatibles. A price of $5,000 to $6,000 per year for complete data-base text with a monthly update is a figure under discussion, says Wimberly.

THINK COGNITIVE. Don Kado, assistant director of technology research for the company, says, "Eventually we will leave traditional data bases behind and go to expert systems and cognitive-processing concepts," adding that Information Handling Services is already using cognitive processing—a way to connect like ideas and thoughts—to build its internal data bases. Again, the vast storage on a CDROM disk makes such a system possible since expert-systems software historically has heavy memory requirements.

Mead Data Central in Menlo Park, Calif., a division of Mead Corp., is working on implementing CDROM technology for its Lexis, Medis, and Nexis data bases for legal, medical, and news use, respectively. However, Mike Janas, product marketing manager for Mead, says a CDROM product is still 18 months from the marketplace.

Another company leveraging off products that already exist is Reference Technology Inc. In addition to its 12-in. video-disk medium, the Boulder, Colo., company has developed the Clasix DataDrive Series 500 CDROM. The personal-computer package—disk drive, cables, and controller card—costs $1,535. The company's 12-in. video product costs $15,900 and stores 800 megabytes, in comparison with the CDROM's 500 megabytes.

Reference Technology is a member of the National Information Standards Organization (NISO) and it, like others, is hoping the industry can settle on the next level of standards—placement of data on the disk. Until such standards are set, not all disks will be interchangeable, even if they use the CDROM physical format. The Sony-Philips physical-formatting standard is giving the CDROM a faster start than larger, less-standardized platters being used with mainframes and minicomputers.

At least one major maker

is cashing in on CDROMs as well. Digital Equipment Corp. began looking at the CD market three years ago when some engineers marched back from a department store carrying a player. This spring, the Maynard, Mass., company announced a CD reader that works with its Microvax I and II computers. Edward Schmid, market-development manager for CD products, claims the company will eventually use such readers across its entire product line.

"We felt it was a technology that would endure over a long time, even after development of write-once and erasable technologies," says Schmid. "We believe that over time, CD will fall to the price of what floppy drives are today. That's where we see the CD curve bottoming out." DEC's CD reader, which it purchased from Philips, is a table-top model that includes reader, cable, and interface for $2,290. The controller can handle an extra reader, which can be added for $1,350.

Philips has been shipping production quantities to DEC since July, says Bert Gall, Philips' manager of product planning. "We see the price dropping rather rapidly with the growing competition from Japan," he continues. By year-end, Philips expects OEM prices for Japanese units to drop to $250 to $300 and for its models to around $500. End-user prices should be around $1,000.

NEW OPPORTUNITIES. Philips isn't claiming that CDROM technology will save the home computer industry, but, says chief engineer Franz Raetzer, "it will expand the applications." Also, CDROM technology will make possible a more powerful personal computer, adds Gall. Gall argues that CDROMs will add cheaper mass-storage capabilities once available only from mainframes.

Hewlett-Packard Co.'s Greeley (Colo.) Division is also doing internal work on its own various types of optical-storage technology, as well as investigating products from OEM vendors, according to marketing manager John Boose.

He sees lack of applications as the only major hurdle facing the CDROM. "It is just a matter of waiting for the right software applications to be developed," he says. "It will happen, but I'm not sure whether it will be in 1986 or 1987. No one knows right now." Boose adds that as those applications become available, HP "would certainly pull up its schedules" to take advantage of them.

Many companies take the view that DRAW is the way to go, and have either introduced compact write-once drives for market or will have them available soon. In fact, the field of competitors for this less-developed technology is far larger than for the more established CDROMs.

Lack of standards and of programming could stall optical storage

At Optotech Inc., in Colorado Springs, Colo., the belief is that because DRAW technology can be geared to the small user, those products are likely to find success faster than the yet-to-come flood of CDROM products. Jeffrey R. Dulude, director of product marketing, says, "Second-sourcing will likely become an issue for many DRAW makers when they approach certain large markets, but for the start of the optical storage evolution, small users are where the action is at." He believes the likelihood of faster acceptance among smaller companies will prove a problem for CDROM vendors.

"With CDROMs, you have to look for a couple key ingredients. One is a large distribution list to whom you can sell the disks and players. The other is a very large static [unchangeable] data base," he says. "Our approach is different because smaller companies can use them to create their own data bases. And information can be dynamic, allowing them to record on site. I think the CDROM people have done a good job hyping their technology, but what is going to be tougher is selling it into products."

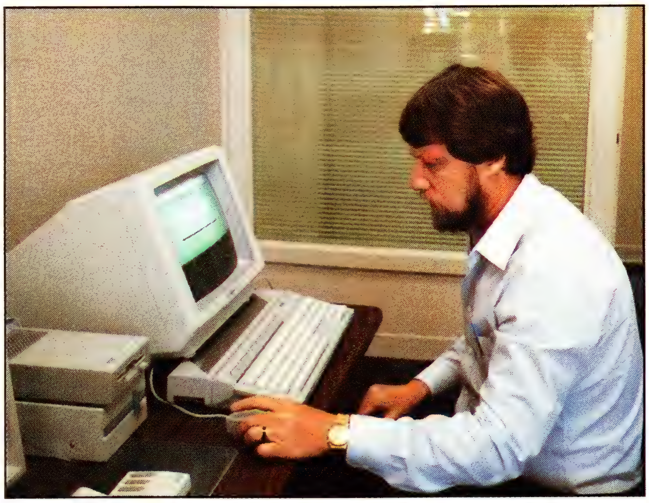
In response, CDROM manufacturers think the write-once technologies will have a hard time convincing consumers they need to store 200,000 pages of personal information. They do see tremendous opportunities for DRAW technology in users, such as hospitals, that must wrestle with large amounts of archived information that is constantly growing.

But whether the preference is DRAW or CDROM, there is another major obstacle: standards. One school of thought is that optical-storage systems may not catch on at all unless strong efforts are made to standardize their vital pieces. For example, CDROM disks are 120 mm, while DRAW disks are 130 mm. Both use different data-transfer speeds and file structures. This poses some obvious compatibility problems for users who might want to read a CD disk in their write-once drive. A few drive manufacturers—notably Philips—are trying to solve the problem with a single standard called Datarom, which would allow future, not present, CDROM platters to work in DRAW drives.

FOR THE USER. "It would probably be in the users' interest if a single standard were adopted," says a spokesman for Sony in Tokyo, This is understandable because Sony has been hurt by the dual standards for video cassette recorders. But even Sony, usually at the forefront of standard-setting, claims it will only "consider" adopting the Datarom standard after it has been set.

In the meantime, optical-drive manufacturers—especially CDROM makers—have another, equally important issue to address. "For the CDROM to succeed in any market, you've got to have 'programming'—content—in the television sense of the word," says Palo Alto Research Group's Jan Lewis. "It's a chicken-and-egg problem. Good 'programming' takes a lot of up-front money," which many computer manufacturers don't have right now or aren't willing to shell out for a less-than-sure thing."

But Lewis, who is not known as a blue-sky analyst, believes the CDROM will definitely take off in a big way in the market. "Growth will start before 1990, and initially will be used more commercially for archival storage," she says. "By 1995, we'll just assume it's part of our businesses and our homes and assume that we never got along without it. But content and standards are very important—content most of all. Who would have bought television receivers or stereo sets if there wasn't something on them?" ☐



PIONEER. Gary Kildall's Activenture pioneered search-and-retrieval software for personal computers hosting CDROMs.

A SURPRISING NEW STARTER IN EUROPEAN ASIC MARKET

EUROPEAN SILICON STRUCTURES GETS A $65 MILLION SENDOFF

by John Gosch

MUNICH

Fueled by $65 million in venture capital, a pan-European semiconductor startup is bidding to become a leader in the potentially large and relatively untapped market for low-volume application-specific integrated circuits. European Silicon Structures, or ESS, is targeting a European market that, unlike standard commodity ICs, is not dominated by the U. S. and Japan.

ICs from the company will be designed for European systems companies in computers and in industrial, military, and consumer electronics. Using the latest silicon-compilation and electron-beam direct-writing techniques, ESS claims it will be able to deliver within two weeks after receipt of order two 5-in. wafers with prototype circuits for just $10,000. This is about one third the cost of two custom chips produced by conventional methods, which take three to five months to deliver. The circuits will be wrought in 2-μm double-metal CMOS. ESS hopes to turn out 1.25-μm double-metal CMOS chips in early 1987.

Though the demand for ASICs has existed for some time, the market is only now emerging because the required techniques for design and fabrication have reached acceptable costs, ESS officials believe. The most important of these are silicon-compilation and electron-beam direct-writing technologies, which allow manufacturers to skip the mask-making process. These technologies provide short-turnaround small-batch prototypes at low cost.

ESS will use design-automation tools based on silicon-compilation techniques developed by Lattice Logic Ltd., Edinburgh, a company that ESS is acquiring. The ICs will be written onto wafers with Perkin-Elmer Corp.'s new Aeble electron-beam system, which can write 0.5-μm lines and produce 9 to 30 layers an hour, depending on feature size.

FOUNDERS. ESS was founded by three big names in European electronics. The chief executive officer and managing director is Jean-Luc Grand-Clément, formerly vice president and assistant general manager of Motorola Europe's Semiconductor Group. The chairmen are Robert W. Wilmot, formerly managing director of Texas Instruments Ltd. in England and now chairman of ICL plc, and Robert R. Heikes, formerly vice president of National Semiconductor Europe and Latin America and now a consultant in France.

PROUD PAPAS. The founders of European Silicon Systems—from the left, Robert W. Wilmot, Jean-Luc Grand-Clément, and Robert R. Heikes—are raising $65 million across Europe.

Underlying the multinational company is a concern over the competitive position of European equipment makers and the problems they face. Given Europe's small and fragmented national markets, many companies make equipment—for example, banking terminals, instruments, industrial gear, and military systems—only in runs of several thousand, says Wilmot. Also, he notes, systems makers must get prototype equipment on the market ahead of competitors to reap the benefits of high profits.

DIVERSE NEEDS. With fast-turnaround and reasonable prices, ESS will serve European systems makers who face such problems. Other European chip companies hope to provide the same service (see "British startups enter semicustom market"). It is the kind of service that U. S. and Japanese commodity-chip vendors, geared to larger and more profitable production runs, are reluctant to provide, Heikes says.

"We are not seeking to push a maximum number of wafers along the production line," adds Helmut Schmitt, ESS vice president and director for Central Europe. "We are aiming to provide speed and service."

ESS plans to have facilities across the Continent. The design-automation technology will come from facilities near London and from Edinburgh University. Chips will be made at a plant in southern France that ESS plans to build later this year. Until then, ESS will rent wafer-fab space in Silicon Valley so that first products can be shipped during the 1986 second quarter. A second European plant will be built by 1990.

The first three design centers should be ready by January 1986 in Paris, Munich, and London. Three more centers will be set up during 1986 in Milan, Stockholm, and Edinburgh. ESS expects to employ around 300 people by the end of 1986 and roughly 1,000 by 1990.

Still, if demand exceeds capacity, ESS will prototype designs and turn chip fabrication over to commodity vendors. "We want to limit ourselves to volumes we can profitably handle with direct-writing technologies," Wilmot says.

The demands of individual buyers may be small, but the potential customer base is large. Though Europe's overall IC market is expected to grow at annual rates averaging 20% in the long term, the market for CMOS-based ASICs is predicted to expand much faster—more like 30%.

Sales of CMOS ASICs in Europe should go from $210 million this year to nearly $680 million in 1988 and to more than $1.4 billion in 1991, predicts ESS. It sees its segment—excluding gate arrays, which it will not make—reaching about $500 million in 1991, up from roughly $80 million this year. "We are aiming for a minimum of 20% of that market by 1990," Wilmot says. That would put ESS's sales at about $100 million by the end of the 1980s.

Industry observers believe the company will succeed. "I am very bullish about the company," says Jim Beveridge, senior industry analyst at Dataquest Ltd., the London affiliate of the San Jose, Calif., market researchers.

ESS is also pan-European in its sources of financing. The money is coming from all corners of the Continent—Great Britain, West Germany, France, the Netherlands, Belgium, and Sweden. The initial funds of about $5 million came from a group of venture capital companies led by Advent in London and Techno Venture Management in Munich, which is backed by such firms as Siemens AG and Daimler-Benz AG.

ESS is now raising another $60 million from European financial institutions and corporate investors to give it a solid operational base. Its officials decline to identify any of its potential sources of funding. "We are seeking a 50-50 balance between industrial and institutional investors," says Wilmot. His company has turned down offers from U. S. investors because it wants to maintain a European identity. ☐

BRITISH STARTUPS ENTER SEMICUSTOM MARKET

European Silicon Structures is just one of several European startups to take on the custom and semicustom chip business. But unlike ESS, which is concentrating on volume production of custom circuits, two new British companies—Array Logic Ltd. and Qudos Ltd.—are going after the gate-array market. Array Logic is selling a 7- to- 10-day prototyping service that uses direct electron-beam writing to commit gate arrays. Next month, Qudos will start to tap the software skills and electron-beam expertise of Cambridge University to provide fast, low-cost prototypes of gate arrays. Both companies plan to move to the more difficult and expensive task of prototyping cell-based semicustom circuits. But they are targeting different sectors of the market.

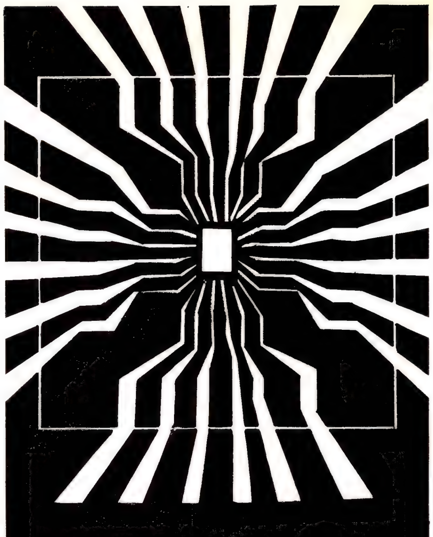
Array Logic, in Melbourn, near London, was formed last November to provide premium-priced fast prototyping and small-batch gate-array production for big-league companies in the defense, computer, and telecommunications sectors. It uses a Cambridge Instruments Ltd. electron-beam fabricator to turn around prototype designs. For low-volume production runs, it uses more conventional optical mask-making techniques. The company, which has already processed its first designs, plans to work in all standard processes—CMOS, bipolar, and emitter-coupled logic—and supports gate-array manufacturers Ferranti Semiconductors, Mullard (a Philips unit), and Plessey Semiconductors. It expects to handle 30 designs this year and over 150 in 1986.

Array Logic is developing in-house the technology to connect double-layer microcircuits. This will allow it to wire the more complex high-density CMOS gate arrays. Single-layer-metalization arrays are connected by a simple patterning and etching process. This selectively removes the metal film that caps the wafer array and leaves only the required connection pattern. Ferranti bipolar arrays and Mullard CMOS arrays are of this type.

To connect multilayer gate arrays, Array Logic has developed the needed equipment for oxide and polyimide deposition, alloying, and wet and dry etching. It has worked closely with its suppliers to align its interconnection technology with theirs. In particular, Array Logic is working with Plessey to implement the double-layer-metal, polyimide-isolated connection technology used in Plessey's 10,000-gate arrays. This capability could also be used to process Plessey's cell-based Megacell semicustom circuits.

Qudos, in Cambridge Science Park, plans to offer low-cost design software to low-volume users. It will also use its direct-write electron-beam technology to process small batches economically with three electron-beam fabricators made in-house. This will enable Qudos to cut capital and wafer-processing costs. It will start by processing gate arrays with single-layer metalization, but later will develop the multilayer technology needed to process more complex gate arrays.

–Kevin Smith



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Circle 31 on reader service card

HOW NASA WILL USE AI IN SPACE

EXPERT SYSTEMS WILL TRACK, MANAGE POWER, AND SCHEDULE PAYLOADS

by Alexander Wolfe

NEW YORK

The National Aeronautics and Space Administration is moving into artificial intelligence in a big way. Its efforts are growing so rapidly that NASA has organized a formal group to coordinate AI projects. "It became obvious that a lot of us were doing very similar work," says group cochairman Tom Davis, AI technology manager at the Future Projects Office at Florida's Kennedy Space Center. "A lot of us had plenty of similar problems."

Researchers at eight NASA divisions are racing to develop expert systems for the space shuttle and space station by the end of the decade. These systems include those for tracking and data acquisition, network control, power management, and robotics and simulation.

The shuttle's role as a space factory will increase sharply over the next few years, as its cargo bay fills with the Spacelab and with experiments aimed at producing new pharmaceuticals, chemicals, and semiconductors in space. The frequency of use also is expected to increase, placing an additional burden on NASA to process payloads quickly and ready each spacecraft for its next flight.

AI is the key to the increased productivity needed to handle this throughput. Currently, the agency's different research and space-flight centers have each carved out a specialized expert-systems niche.

The space station is the object of much of NASA's current AI research. Scheduled for launch in 1992, the space station will be the first permanent U. S. presence in space. It will function as a 300-mile-high orbiting research facility, factory, test and service center, and observation platform. It will carry a 450-ft-long power tower from which projecting arms containing solar panels or parabolic mirrors grab the sun's energy. The crew's living quarters and all experiments will be housed in five modules—called common modules—attached to the craft's body.

SPACE TASKS. On board the shuttle and the space station, expert systems will manage spacecraft resources (power, for example). Other likely tasks are controlling experiments and helping perform repairs. "There's a need in terms of increasing productivity—reducing the number of people required to do a job," says AI group cochairman Robert Brown, who is chief of the Technology Development and Applications Branch at the Johnson Space Center, Houston.

NASA's AI researchers will compare notes at its Expert Systems Applications Working Group meetings, to be held every two to three months. The group, which met for the first time last week at the Johnson Space Center, will also develop requirements for NASA-wide AI training programs.

At the Kennedy Space Center, "we are trying to build expert systems that will be assistants to engineers, planners, and managers of shuttle processing and cargo payload processing," says AI technology manager Davis. Kennedy is responsible for processing and launching the shuttle and for processing all the shuttle's cargo.

Now in the works is a planning and scheduling system for payload processing. Called Empress, for Expert Mission Planning and Replanning Scheduling System, the design is geared to the processing needs of Spacelab, the experimentation payload that rides on board the shuttle. "Spacelab happens to be one of the most complex payloads that we process and get ready to launch on the shuttle. Once Empress is built for that, we feel we can use it on just about anything," says Davis.

On another front, a new AI system

(continued on p. 37)

EXPERT CONTROL. Expert systems will aid mission controllers by automating many shuttle and space-station functions.

Circle 33 on reader service card →

146-1471

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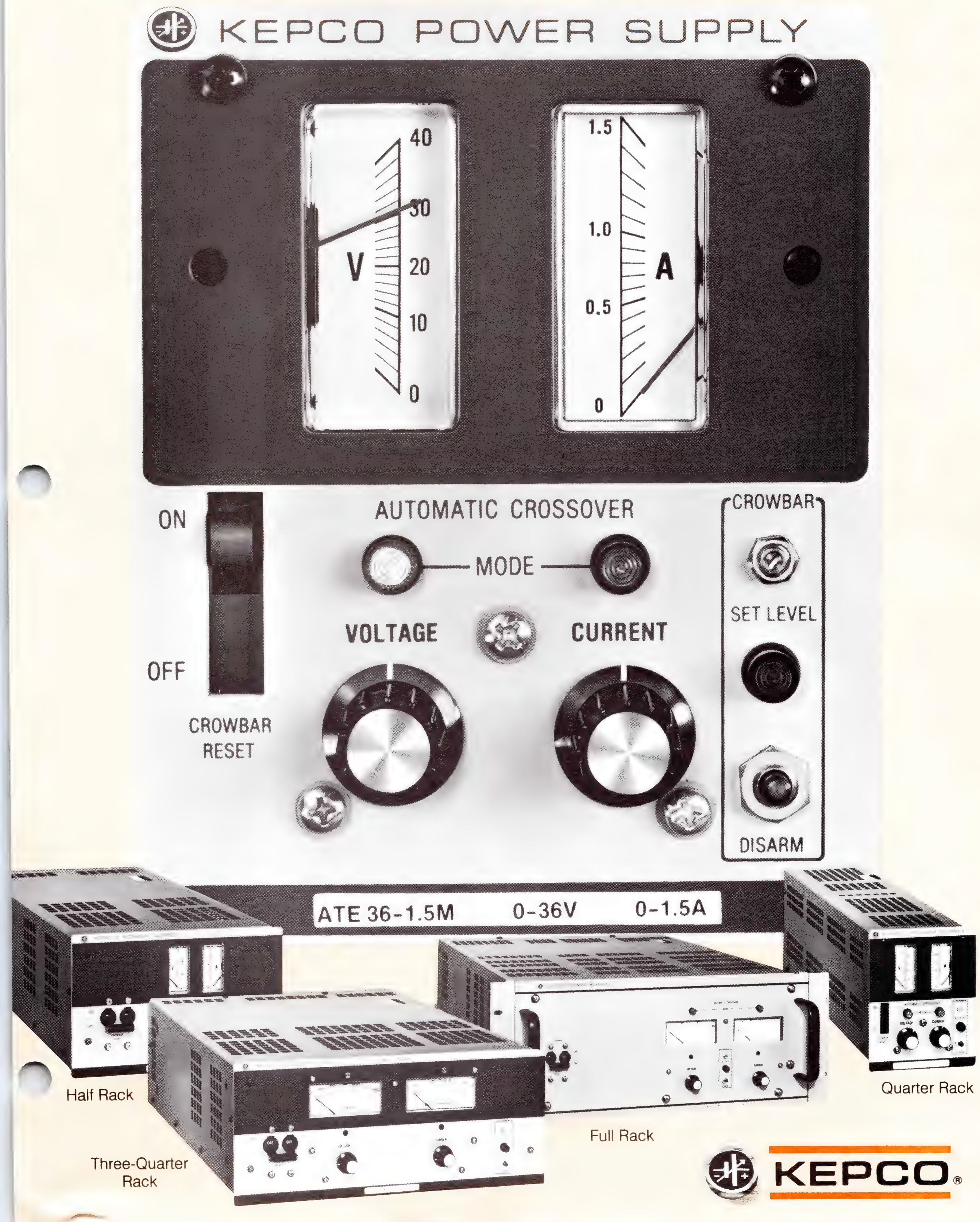

Half Rack

Three-Quarter Rack

Full Rack

Quarter Rack

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Specification	Condition	Rating / Description
Source voltage	Selectable	95-113, 105-125, 190-226, or 210-250V a-c 50-65 Hz, 1φ
Input current	Nominal voltage	See Table 1
Output range	Continuously adjustable or programmable	0-100%
Control voltage[1]	Local	10-turn rheostat
	Remote	0 to 10V signal
Control current[1]	Local	10-turn rheostat
	Remote	0 to 1V signal
Remote error sensing	Both terminals	0 to 0.5V / lead
Program speed	Slow mode	$\tau = R_L \times C_{out}$ (see model table)
	Fast mode	See Table 2
Voltage recovery	Step load current	50μsec typ. 100μsec max. to recover within 10 mV.
Current recovery	Step load voltage	Exponential with RC time-constant $\tau = R_L \times C_{out}$
Mode flags (optically isolated flags delivered to rear connector)	Voltage	Green LED Front Panel Indicator
	Current	Amber LED Front Panel Indicator
	OVP	Red LED Front Panel Indicator
OVP control	Local	Trimmer-adjustable
	Remote	0-10V signal, or may be set to track output voltage
Crowbar trigger time	Slow mode	50μsec.
	Fast mode	500μsec delay (to avoid false triggering)
OVP action	When tripped	1) Short output with SCR 2) Trip a-c circuit breaker 3) Generate optically isolated flag signal
Series operation		To the 500V limit of isolation voltage
Parallel operation		Master / slave operation and redundant connections are possible
Isolation	Common mode current	5μA rms, 50μA peak-to-peak
	Test-voltage	500V d-c
Temperature	Storage	– 40°C to 85°C
	Operating	0° to + 55°C (derate to 90% of rated current at + 65°C)
Cooling	Exhaust to the rear	Built-in fan (2 fans for size E models)
Standards		IEC 478 — Nema PY-1-1972
Connectors, programming	Unwired	PC-12
	Wired (local) size A,B	PC-13
	Wired (local) size C,D,E	PC-14
Connectors, output d-c	Mounted on the rear apron	Barrier-strip or binding posts
Connectors, input a-c		Detachable line cord
Meters	Size A,B,C	1½'' ± 3% taut band
	Size D,E	2½'' ± 2% taut band

Table 1

SOURCE CURRENT
(Measured, worst case,
at 125V a-c source voltage)

Size A–1.4A max.
Size B–2.4A max.
Size C–6.0A max.
Size D–11.0A max.
Size E–20.0A max

Table 2

Output Voltage Rating	Bandwidth (– 3db)	Programming Time Constant
6V	53 KHz	3.0μsec.
15V	21 KHz	7.5μsec.
25V	13 KHZ	12.5μsec.
36V	9 KHz	18.0μsec.
55V	6 KHz	27.5μsec.
75V	4 KHz	37.5μsec.
100V	3 KHz	50.0μsec.
150V	2 KHz	75.0μsec.
325V	1 KHz	150.0μsec.

---

[1] Two uncommitted operational amplifiers are provided for signal processing (scaling, summing, etc.). Control is with respect to the positive output sense terminal.

Kepco ATE™ series... are linear power supplies which offer:

- full external control over both voltage and current with automatic crossover and separate voltmeter and ammeter for continuous output monitoring. Local control is through 10-turn rheostats on the front panel. Remote control is through a fixed gain power amplifier scaling from an input of 10 volts to the rated voltage. Digital input via the GP IB (IEEE-488) is possible with Kepco digital interface programmers.
- user selectable *slow* or *fast* mode of operation. In the slow mode, large output and feedback capacitors minimize output noise, making the ATE ideal for delivering constant voltage; in the fast mode, the ATE can follow rapidly changing load voltages to deliver constant current, or follow high speed voltage or current programming.
- two built-in, uncommitted amplifiers for scaling, summing, or other manipulation of programming signals. Both the voltage and the current control channels have full zeroing and calibration facilities for compatibility with Kepco's digital interfaces.
- programmable/tracking overvoltage protection.

For 19″ rack mounting of sizes A, B, C, & D, use adapters RA 24, RA 32, or RA 37; "ears" are provided for direct mounting of size E.

This KEPCO product is backed by a firm **5-YEAR WARRANTY**

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The full rack model is supplied with brackets for direct mounting in a standard 19-inch rack.

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STATIC STABILIZATION TABLE

INFLUENCE QUANTITY	OUTPUT EFFECTS VOLTAGE MODE Typ.	Max.	OUTPUT EFFECTS CURRENT MODE Typ.	Max.	OFFSETS (4) ΔE_{io}	ΔI_{io}
SOURCE VOLTAGE (min.–max.):	<0.0005% E_0 max.	0.001% E_0 max.	<0.002% I_0 max.	0.005% I_0 max.	<1 μV	<1 nA
LOAD (no load–full load):	<0.001% E_0 max.	0.002% E_0 max.	<0.5 mA(1)	1 mA(1)	—	—
TIME (8-hour drift):	<0.005% E_0 max.	0.01% E_0 max.	<0.01% I_0 max.	0.02% I_0 max.	<20 μV	<1 nA
TEMPERATURE, per °C:	<0.005% E_0 max.	0.01% E_0 max.	<0.01% I_0 max.	0.02% I_0 max.	<20 μV	<2 nA
RIPPLE and NOISE(2) rms:	<0.1 mV	0.3 mV	<0.01% I_0 max.	0.03% I_0 max.	—	—
(Slow Mode) p-p:(3)	<1 mV	3 mV	<0.1% I_0 max.	0.3% I_0 max.	—	—
RIPPLE and NOISE(2) rms:	<1 mV	3 mV	<0.01% I_0 max.	0.03% I_0 max.	—	—
(Fast Mode) p-p:(3)	<10 mV	30 mV	<0.1% I_0 max.	0.3% I_0 max.	—	—

(1) In slow mode, the leakage current through the output capacitor adds approximately 0-6 mA to the current mode load effect.

(2) One terminal must be grounded for this measurement, or connected so that common mode current does not flow through the load or, in current mode, through the current-sensing resistor.

(3) Peak-to-peak ripple is measured over a 20 Hz to 10 MHz bandwidth.

(4) Uncommitted amplifier offsets.

$5\,{}^{7}/_{32}$″ H x $4\,{}^{5}/_{32}$″ W x $17\,{}^{1}/_{8}$″ D*
(132.6mm H x 105.6mm W x 435.0mm D)*
Weight: 14 lbs. (6.4 kg.)

SIZE "A"

MODEL	D-C OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-5M	0-6	0-5	24 μΩ	0.5 μH	5 μH	12 kΩ	1,000 μF	1 μF
ATE 15-3M	0-15	0-3	100 μΩ	0.5 μH	5 μH	30 kΩ	450 μF	0.4 μF
ATE 25-2M	0-25	0-2	250 μΩ	1 μH	10 μH	50 kΩ	250 μF	0.25 μF
ATE 36-1.5M	0-36	0-1.5	480 μΩ	1 μH	10 μH	72 kΩ	200 μF	0.2 μF
ATE 55-1M	0-55	0-1	1.1 mΩ	2 μH	20 μH	110 kΩ	150 μF	0.15 μF
ATE 75-0.7M	0-75	0-0.7	2.15 mΩ	2 μH	20 μH	150 kΩ	110 μF	0.1 μF
ATE 100-0.5M	0-100	0-0.5	4 mΩ	4 μH	40 μH	200 kΩ	50 μF	0.05 μF
ATE 150-0.3M	0-150	0-0.3	10 mΩ	4 μH	40 μH	300 kΩ	55 μF	0.02 μF

QUARTER RACK

SIZE "B"

$5\,{}^{7}/_{32}$″ H x $4\,{}^{5}/_{32}$″ W x $17\,{}^{1}/_{8}$″ D*
(132.6mm H x 105.6mm W x 435.0mm D)*
Weight: 17 lbs. (7.7 kg.)

MODEL	D-C OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-10M	0-6	0-10	12 μΩ	0.5 μH	5 μH	12 kΩ	1,800 μF	2 μF
ATE 15-6M	0-15	0-6	50 μΩ	0.5 μH	5 μH	30 kΩ	1000 μF	0.8 μF
ATE 25-4M	0-25	0-4	125 μΩ	1 μH	10 μH	50 kΩ	500 μF	0.5 μF
ATE 36-3M	0-36	0-3	240 μΩ	1 μH	10 μH	72 kΩ	350 μF	0.4 μF
ATE 55-2M	0-55	0-2	0.55 mΩ	2 μH	20 μH	110 kΩ	200 μF	0.3 μF
ATE 75-1.5M	0-75	0-1.5	1 mΩ	2 μH	20 μH	150 kΩ	110 μF	0.2 μF
ATE 100-1M	0-100	0-1	2 mΩ	4 μH	40 μH	200 kΩ	80 μF	0.1 μF
ATE 150-0.7M	0-150	0-0.7	4 mΩ	4 μH	40 μH	300 kΩ	55 μF	0.04 μF

HALF RACK

SIZE "C"

$5\,{}^{7}/_{32}$″ H x $8\,{}^{11}/_{32}$″W x $17\,{}^{9}/_{64}$″D*
(132.6mm H x 211.9mm W x 432.4mm D)*
Weight: 35 lbs. (15.9 kg.)

NEW

MODEL	D-C OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-25M	0-6	0-25	4.8 μΩ	0.5 μH	5 μH	12 kΩ	11,000 μF	5 μF
ATE 15-15M	0-15	0-15	20 μΩ	0.5 μH	5 μH	30 kΩ	5,800 μF	2 μF
ATE 25-10M	0-25	0-10	50 μΩ	1 μH	10 μH	50 kΩ	2,900 μF	1.25 μF
ATE 36-8M	0-36	0-8	90 μΩ	1 μH	10 μH	72 kΩ	2,400 μF	1 μF
ATE 55-5M	0-55	0-5	0.22 mΩ	2 μH	20 μH	110 kΩ	1,400 μF	0.75 μF
ATE 75-3M	0-75	0-3	0.5 mΩ	2 μH	20 μH	150 kΩ	850 μF	0.5 μF
ATE 100-2.5M	0-100	0-2.5	0.8 mΩ	4 μH	40 μH	200 kΩ	375 μF	0.25 μF
ATE 150-1.5M	0-150	0-1.5	2 mΩ	4 μH	40 μH	300 kΩ	275 μF	0.1 μF
ATE 325-0.8M	0-325	0-0.8	8.1 mΩ	100 μH	1 mH	650 kΩ	180 μF	0.01 μF

THREE-QUARTER RACK

SIZE "D"

$5\,{}^{7}/_{32}$″ H x $12\,{}^{17}/_{32}$″ W x $17\,{}^{9}/_{64}$″ D*
(132.6mm H x 318.3mm W x 435.4mm D)*
Weight: 43 lbs. (19.5 kg.)

MODEL	D-C OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-50M	0-6	0-50	2.4 μΩ	0.5 μH	5 μH	12 kΩ	12,000 μF	10 μF
ATE 15-25M	0-15	0-25	12 μΩ	0.5 μH	5 μH	30 kΩ	8,000 μF	4 μF
ATE 25-20M	0-25	0-20	25 μΩ	1 μH	10 μH	50 kΩ	5,800 μF	2.5 μF
ATE 36-15M	0-36	0-15	48 μΩ	1 μH	10 μH	72 kΩ	4,900 μF	2 μF
ATE 55-10M	0-55	0-10	0.11 mΩ	2 μH	20 μH	110 kΩ	2,900 μF	1.5 μF
ATE 75-8M	0-75	0-8	0.19 mΩ	2 μH	20 μH	150 kΩ	1,200 μF	1 μF
ATE 100-5M	0-100	0-5	0.4 mΩ	4 μH	40 μH	200 kΩ	600 μF	0.5 μF
ATE 150-3.5M	0-150	0-3.5	0.86 mΩ	4 μH	40 μH	300 kΩ	440 μF	0.2 μF

FULL RACK

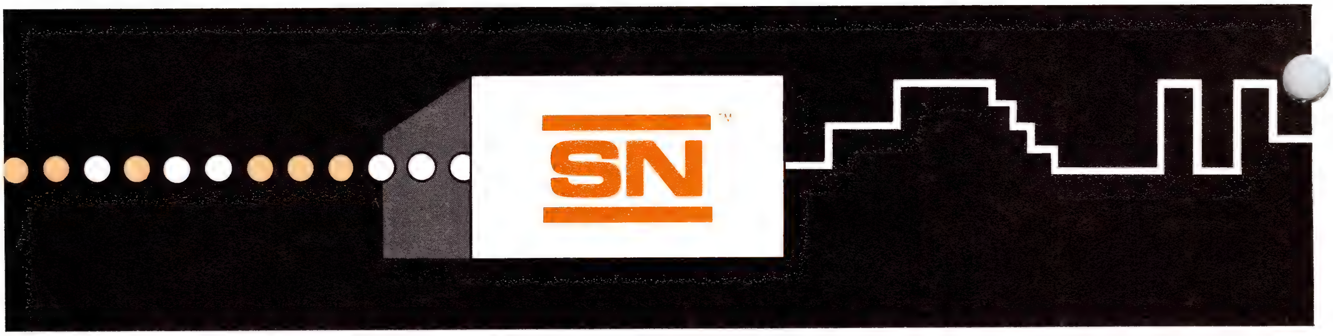
SIZE "E"

$6\,{}^{31}/_{32}$″H x $16\,{}^{1}/_{2}$″W x $20\,{}^{1}/_{64}$″ D*
(177.0mm H x 419.1mm W x 508.4mm D)*
Weight: 87 lbs. (39.5 kg.)

MODEL	D-C OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-100M	0-6	0-100	1.2 μΩ	0.5 μH	5 μH	12 kΩ	22,000 μF	15 μF
ATE 15-50M	0-15	0-50	6 μΩ	0.5 μH	5 μH	30 kΩ	12,000 μF	6 μF
ATE 25-40M	0-25	0-40	12.5 μΩ	1 μH	10 μH	50 kΩ	11,000 μF	4 μF
ATE 36-30M	0-36	0-30	24 μΩ	1 μH	10 μH	72 kΩ	9,500 μF	3 μF
ATE 55-20M	0-55	0-20	55 μΩ	2 μH	20 μH	110 kΩ	5,200 μF	2.25 μF
ATE 75-15M	0-75	0-15	0.1 mΩ	2 μH	20 μH	150 kΩ	3,400 μF	1.5 μF
ATE 100-10M	0-100	0-10	0.2 mΩ	4 μH	40 μH	200 kΩ	1,200 μF	0.75 μF
ATE 150-7M	0-150	0-7	0.42 mΩ	4 μH	40 μH	300 kΩ	1,050 μF	0.3 μF

Add 2½" (63.5mm) for connector protrusion.

*Based on 0.5 mA load effect in FAST mode.



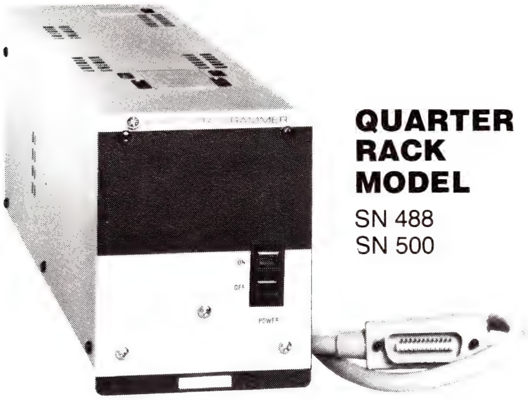
Talk digital to your power supplies

A Kepco Series SN Digital Interface will make them understand

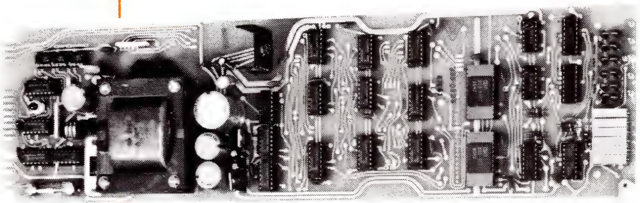
The Kepco Interfaces accept commands in ASCII and translate them into an analog voltage output that ATE and other Kepco programmable power supplies understand perfectly. The SN 488 and SNR 488 take byte serial, bit parallel input data from the IEEE-488 bus with the IEEE-488 handshake protocol; the SN 500 accepts data from buses using bit-parallel data transfer. The output of all interfaces is selectable ±1V or ±10V.

Both the SN 488 and SN 500 are quarter rack sized models which offer a choice of one- or two-channel operation. With two channels you can, for example, use one to control the voltage of an ATE and the other to control the current. Or, because the two channels are completely isolated from each other, you can use them to control two separate instruments. If you start out with a one-channel unit, you can easily upgrade it to two with a plug-in card.

If you want to control more than two instruments (or two functions of more than one instrument), buy our SNR 488-4, which can hold up to four dual-channel cards, or our SNR 488-8, which can hold eight. The multi-channel interfaces are accessed through a single IEEE-488 connector.

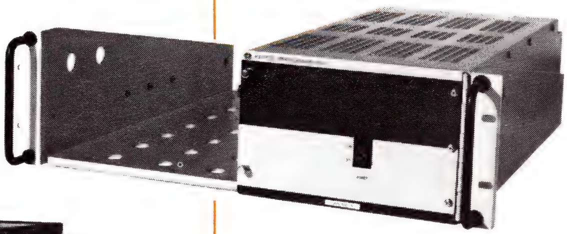


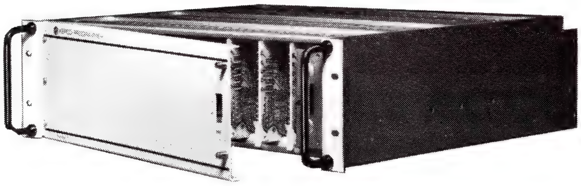
QUARTER RACK MODEL
SN 488
SN 500



PLUG-IN PROGRAM CARDS
SN 488B and SN 488D Dual Channel Plug-In Cards for SNR 488-4 and SNR 488-8. The "B" cards take data coded in hexadecimal, the "D" cards in BCD.

HALF RACK MODEL
SNR 488-4





FULL RACK MODEL SNR 488-8

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CENTERPIECE. NASA's AI researchers will meet at the Johnson Space Center, Houston.

will begin final testing at Kennedy this November. Running on Symbolics 3600 hardware is the LOX—for liquid oxygen—expert system, which will be a diagnostic system for the loading of liquid oxygen into the shuttle.

A major goal of the tests is to prove out the technology. In 1986, a three-year project to expand the basic diagnostic system into a complete automated testing and control system will begin. The idea is to eventually upgrade many of NASA's ground systems. "The diagnostics system we built for the LOX loading is a basic diagnostic shell," says Davis. "It could actually be used to build a diagnostic expert system for almost any fluid system. We think it could be used for electrical systems, too."

APPLYING EXPERTS. At Goddard Space Flight Center in Greenbelt, Md., an active effort to apply expert systems to the area of spacecraft tracking and data acquisition is under way. "There are a number of problems in scheduling the space and ground networks—fault isolation, monitoring and control, and fault diagnosis for the spacecraft themselves and payloads. Also, because of increasing complexity, there are areas where we want to look at expert systems to act as advisers to people in control centers and as network schedulers," says John Dalton, chief of the Data Systems and Technology Division.

Now in the detailed planning phase is an application involving the space network and network-control center. NASA's network control center, in White Sands, N. M., routes space communications through the agency's tracking and data-relay satellite (TDRS). "You have to schedule the spacecraft being in view of the TDRS," says Dalton. Also, there are different antennas and different transponders that have to be selected, depending on the mission. "We're looking at using automated tools for scheduling those."

NASA's plans call for the launch of two additional TDRSs this year. "As you add more TDRSs and as more payloads get launched, the scheduling problem becomes something that you can't handle with strictly human decision making," says Dalton. "You want to be able to allow the human operators to make the more complex decisions, and use the expert systems to make the more routine ones, and provide them [the humans] with alerts and alarms."

Controlling electrical power systems with expert systems is under study at Marshall Space Flight Center, Huntsville, Ala. A common-module power-management and -distribution system for the space station is in the early development stages. "We're looking at expert systems for such things as a dynamic planner and scheduler for the loads," says David Weeks, chairman of the AI group at Marshall. For example, the system would allow the space station to shift loads in response to changes in power availability.

On board, expert systems will manage spacecraft resources

A separate portion of the system would flag faults for immediate correction. This expert system would diagnose where a fault occurred and advise the crew on the most efficient way to correct it. This helping-hand approach is important, says Weeks, "because there will be rotating crews, and we don't want them to spend a lot of time having to learn each of the subsystems on board." The system will free the crew to concentrate full-time on their scientific duties.

Power-management AI is necessary because NASA is facing its own energy crisis. The complexity of the power problem has grown enormously since the Skylab of the early 1970s. "That was an 8-kW bus. It required 15 people for ground support to analyze, monitor, and control the power system on board," says Weeks. "The space station will start off with a minimum of 75 kW of power to the loads and will grow to eventually at least 300 kW. There's no way that NASA can afford the ground support or crew involvement to manage such a system without it being at least nearly autonomous."

Handling the huge amount of data generated by the power system is another objective. "We can't keep all that data on board for storage, and we can't downlink it all," says Weeks. "We've got to streamline that data somehow." An expert system will determine whether data is immediately critical or should be downlinked, stored for later analysis, or simply thrown away.

Marshall's test bed for power-management distribution will be completed by 1987. It will contain three or four different expert systems. Early prototypes should be running by the end of 1986, Weeks says.

Robotics and simulation also go hand in hand at Marshall. Simulations—of space-station control mechanisms or a robot's arm movements, for example—are based on a complex series of equations. Previously, an expert was needed to tweak the various inputs and variables during simulation runs.

A current project is an expert system that lets the "engineer interface directly with the simulator without knowing all the gory details," according to Ken Fernandez, robotics task lead engineer at Marshall. Now the operator needs only to specify the experiment to be run, and the expert system takes over. Phase 1 of this NESS, for NASA expert simulation system, has just recently been completed. Vanderbilt University's AI research center developed NESS under contract to Marshall.

At the same time, Marshall is developing control equations for experimental robots. The center has a full-scale mockup of a robot like those that will service satellites in orbit. Eventually, computer-graphics simulations of these robots may be linked with expert systems to control the servicing missions.

SPACE RACE. Although the researchers' efforts currently are relatively relaxed, researchers will eventually have to beat the clock. NASA's technology freeze date—the point when the design can no longer be changed—for the space station is 1987. "In other words, those technologies which are feasible at that point will be incorporated in the space station, and those which are not will most likely be eliminated," says Marshall's David Weeks. "So that's why we're in a hurry to develop the technology and get some good in-house capability." ☐

SAMSUNG CHARGES AHEAD DESPITE RECESSION

KOREAN GIANT GOES AFTER U. S. AND JAPANESE MAKERS IN TELECOM AND MEMORY CHIPS AS WELL AS IN TV SETS

SEOUL, SOUTH KOREA

Americans are starting to see a new name plastered on billboards, and it could become a household word in coming years. That name is Samsung.

Samsung Electronics Co. is already the leading South Korean electronics manufacturer. Founded in 1967, the company reported sales of $1.35 billion last year; it expects $1.7 billion in sales this year. Samsung accounts for about a quarter of all Korea's exports in consumer electronic goods, primarily color TVs, microwave ovens, and video cassette recorders.

Undaunted by the worldwide electronics industry recession, Samsung is aggressively pursuing territory claimed by established Japanese and American companies—not only in consumer electronics but in telecommunications and large-scale memories as well.

"We are emphasizing corporate change, orienting the company to the 21st Century," says Chung Jae-un, president since 1982. In 1983, it opened up a 64-K dynamic random-access-memory production facility, and just last summer the company dedicated a 6-in.-wafer fabrication plant in Suwon—the first plant of its kind outside the U. S. and Japan.

ONWARD. "Korea and semiconductors signify the future," says Chung Jae-un.

The company plans to have a 1-Mb DRAM prototype developed by the end of next year. Last year, it developed a 16-K electrically erasable programmable read-only memory at its Santa Clara, Calif., research lab; it is working on a 64-K EEPROM as well as a 64-K static RAM. It is also making 8- and 16-bit central processing units under license from Intel Corp. and will eventually produce 8- and 16-bit microprocessors for the Asian and U. S. markets.

Samsung's penetration of the U. S. consumer market has not been without setbacks, however. Last year, the International Trade Commission found Samsung guilty of dumping TV receivers and imposed a 12% tariff on all Samsung TVs entering the U. S.

Chung perceives a high-tech mission for the $9.8-billion Samsung Group (see "An empire that goes from chips to chip shots"). "In the future, computers and communications will be the same thing, joined and backed up by semiconductors. Korea and semiconductors signify the future."

Chung is also the president of Samsung Electron Devices Co., the largest manufacturer and exporter of TV picture tubes in Korea, and Samsung Electronic Parts Co., a vertically integrated manufacturer of electronic parts and components for TVs, VCRs, computers, and industrial machines.

FOREIGN AID. To ensure that Samsung gets the technology it needs to become a world leader in electronics, Chung has helped forge nearly a dozen ties to foreign electronics companies in recent years. In 1976, Samsung became the distributor of Hewlett-Packard Co. computers in South Korea, a relationship that helped HP bag 20% of the local computer market. Last year, the two companies formed a joint venture to produce and market the HP3000 series 44 minicomputer in Korea.

Chung reports that the two partners have decided to make Korea the production base for HP's activities in East Asia, and the companies are working feverishly to develop a new minicomputer tailored to the graphics software needs of the Asian market. Last summer, Samsung also began supplying Sinclair Research Ltd., in Cambridge, England, with a 32-bit microcomputer on an original-equipment-manufacturer basis.

Chung has moved aggressively to tap other sources of technology: he has struck a deal with Japanese video equipment maker Akai Electric Co. to acquire technology for making video recording heads. Though Samsung only began selling VCRs overseas last year, it claims to have already grabbed 15% of the U. S. market and estimates it will sell $100 million worth of VCRs this year worldwide.

It is in TVs, however, that the company has made its biggest impact in the consumer electronics business. A decade ago, Samsung started a joint venture with Corning Glass Works Inc. to make color picture tubes. With that technology, Samsung has to date produced more than 700 million color TV sets and hopes to sell nearly half a billion dollars' worth of sets around the world this year. In the last few years it has also opened two color TV plants overseas, one in Estoril, Portugal, in 1982, and a second last year in Roxbury, N. J.

Samsung is already shipping samples of its 256-K DRAM

Samsung Electronics has no intention of stopping at TVs. It is not only the flagship of the electronics-related companies in the Samsung Group—there are eight such companies—it is also the mother of Samsung Semiconductor & Telecommunications Co. The new company was formed three years ago when Samsung Electronics set its Semiconductor Division afloat.

Samsung Semiconductor—well known for its world sales lead in CMOS integrated circuits for use in watches and clocks and for its recent introduction of a 64-K DRAM—had sales of $65.5 million last year. It expects sales to increase by 60% to 70% per year in the near future, about the same pace Samsung Electronics has followed.

Samsung Semiconductors' main sales line, however, is telecommunications. Sales of its telecommunications line, which includes telephones, private branch exchanges, and optical-fiber cable, amounted to $178.5 million of last year's total $245 million in sales. Not only is it making and shipping optical fiber cable for an unnamed U. S. company, but it is also producing a line of private branch exchanges. One PBX, built with Rolm Corp. technology, is designed for use with 32-bit computers and can handle as many as 12,000 lines.

SAMSUNG'S GROWTH EXPLODES ($ MILLIONS)

	Total sales	Exports
1980	233.57	206
1981	370.04	303
1982	426.40	327
1983	707.01	507
1984	1,351.65	764
1985 (estimated)	1,726.00	989

SOURCE: KOREA INVESTMENT TRUST CO. AND ELECTRONICS

Though tiny compared to its parent, Samsung Semiconductor & Telecommunications is responsible for many of the group's exciting technology developments. The company does more than supply Seiko of Japan with watch chips. It is also working closely with the Japanese company on advanced CMOS technology. Pointing out that the company really only started its semiconductor business two years ago, Chung adds, "We are moving very rapidly."

STOCK PRICES DROP. Samsung started shipping 64-K DRAMs last October. The new plant's capacity stands at about 6 million units per month, but because of the current recession, production is down to 2 million units per month. Concern over the recent recession has pushed down the price of Samsung Semiconductor & Telecommunications stock by one third since September 1984, to $1.49 a share, reports Seoul's Daewoo Securities Co.

Samsung has already begun shipping samples of its new 256-K DRAM, and hopes to be filling large orders before the year is out.

Because of the sorry state of semiconductor affairs in the U. S., more than a few analysts have suggested Samsung should have looked where it was stepping. Calling semiconductors "a big white elephant," one American lawyer in Seoul says Samsung is going to "lose its shirt" by investing heavily in a technology that will soon be outdated.

Others cite Samsung's strategy of aggressively cutting prices to gain color-TV market share in the U. S. They predict Samsung will try the same tactic to get into the semiconductor market. "When there are 16 semiconductor companies lined up ahead of you, you're going to have to dump just to get noticed," says a leading semiconductor-market analyst in San Francisco.

Dismissing the criticism, Chung replies that "some people misunderstand Samsung. We don't do things that will endanger the community. We do what is good for the country and for the world. That is priority No. 1."

Samsung proudly and frequently claims that it was ahead of the European electronics companies in introducing 64- and 256-K DRAMs. "I am convinced that the semiconductor industry holds the key to the Korean economy," said Samsung chairman Lee Byung-chull at the opening of the 64-K DRAM plant in Suwon in October 1983.

Though the Koreans are becoming a significant market power in consumer electronics, they still have some distance to go before they make a similar impact in large-scale memory markets. And for all the warning flags being posted from San Francisco to Boston, Samsung sold only $5 million worth of semiconductors in the U. S. last year, a very thin slice of the $12 billion pie. *–Jonathan Joseph*

AN EMPIRE THAT GOES FROM CHIPS TO CHIP SHOTS

The Samsung Group is a vast economic enterprise. It owns some 30 business concerns, ranging from country clubs to steel mills to medical-equipment manufacturers. It is the oldest of the large Korean *chaebol,* or conglomerates, starting off as a small trading company during the Japanese occupation in 1938 to handle trade primarily between Manchuria and Japan. In the 1950s, after the Korean War, Samsung moved into light industry, founding a leading sugar refinery and textile mill. It also began Samsung Construction Co. and in the early 1960s invested in land development. The group soon entered the service sector, and now owns two insurance companies, two of the top hotels in Seoul (including the Shilla, managed by Tokyo's world-famous Okura Hotel), and Seoul's most elegant department store, the Shinsegae.

The Samsung Group ranked first among the chaebol in terms of sales during 1984, according to a Seoul newspaper survey, with consolidated sales of $9.753 billion. Hyundai Corp. was a close second with $9.750 billion in consolidated sales. Hyundai, however, has more assets ($8.88 billion) than Samsung ($7.3 billion) and a healthier net profit to total sales of 1.25%, compared with Samsung's 1.04%.

BOTTOM LINES

COMPUWARE BUYS POWERBASE SYSTEMS

Compuware Corp., a large, privately held software and professional services company, has entered the personal computer industry with the acquisition of Powerbase Systems Inc., developer of the Power-base microcomputer database-management system. Compuware will continue to market Power-base to retail outlets, but it will expand distribution directly to business using its own systems-software sales force. Sales, marketing, and administration for Powerbase Systems will move to Compuware's Birmingham, Mich., headquarters; product development will remain in New York.

ALLNET AND LEXITEL MERGE TO SURVIVE

Alternative long-distance carriers Allnet Communications Services Inc. and Lexitel Corp. are merging in order to strengthen their hand during the expected shakeout of alternative carriers. "Companies will have to be at the $1 billion rate to survive the next decade," says a company representative. The new company, not yet named, will take over the microwave networks used by Allnet and Lexitel. Allnet, the third-largest carrier behind MCI and Sprint, is a national carrier; Lexitel is concentrated in the Great Lakes area.

SILICON GRAPHICS RAISES $10 MILLION

Silicon Graphics Inc. has completed a $10 million third round of venture capital funding. The Mountain View, Calif., manufacturer of stand-alone work stations will retire bank debt and fund expansion of the company. It reported sales of more than $21 million for fiscal 1985, four times its recorded sales in fiscal 1984.

JOBS FOR MANAGERS TO INCREASE SLIGHTLY

Jobs for high-technology managers will rise only 0.95% this year, largely because of poor showings by semiconductor and older communications companies, says a study by Christian & Timbers. The communications industry continues to vary in its needs: companies founded before 1975 show a 7.8% decrease in demand for 1985; those founded after 1975 expect to need 21.3% more managers. Semiconductor companies had 24.6% more managerial jobs in 1984 than in 1983, but the survey shows that demand should drop 12% this year.

PLAYERS

PATIENCE WINS CHINA DEALS, SAYS ITT's JENISCH

FREIBURG, WEST GERMANY

It's a market unlike any other," says Horst F. Jenisch, director of technology transfer at the ITT Semiconductors Group. "It encompasses about a quarter of the world's population. Targets are pursued with determination, and rather than [wanting] finished products, it is open to the foreign technologies required to make products on their own as one way of building up a home industry."

The market in question is the People's Republic of China, still a technological infant. There, in the industrial town of Tianjin, the Chinese are producing TV tuner diodes with ITT's know-how and equipment, as well as with Chinese workers trained at Freiburg-based Intermetall GmbH, the group's lead house [*Electronics*, June 24, 1985, p. 18]. All this is due to a $4 million agreement that technology-transfer expert Jenisch has hammered out with the Chinese.

Now the 52-year-old ITT executive is negotiating a deal that calls for the transfer to China of the know-how and machinery needed to make transistors, also for consumer applications. "If we had the engineering manpower to spare, we could take on similar contracts involving integrated circuits," he says.

Jenisch advises Western companies that want to operate in the Chinese market that time and patience are needed. The Chinese take a long-range view of things and are meticulous and thorough negotiators, examining all facets of a deal from every angle. Having a presence in China is also important. To that end ITT, like other Western corporations, opened offices in that country.

Still another factor is establishing a basis of confidence, he says. To achieve this, companies should always delegate the same people to negotiate deals. In time they will be come familiar to the Chinese. Finally, entering negotiations well prepared and versed in all technical and business-related aspects of a deal is essential.

WELL TRAVELED. The ITT director, who has traveled to China at least 25 times in the past eight years, is also an authority on the state of the art in components in the Eastern Bloc. He has been instrumental in selling ITT semiconductor technology for consumer products to Hungary and the Soviet Union. "But since Afghanistan, nothing goes anymore. Deals are no longer approved by the West German government." So interest has shifted to the Orient.

Jenisch, a 23-year Intermetall veteran, says the Chinese are not after ready-made components. "Now they want the know-how to make everything themselves, so as to become autonomous in electronics." They follow the trade literature to keep up with the latest in technology, he says, "and they want it."

But unlike some East European countries that acquire outside technology only to make components they can sell back to the West, the Chinese are producing solely for their own use. Their market is so big that little, if anything, can be spared for exports.*–John Gosch*

NEGOTIATOR. ITT's Horst F. Jenisch says the Chinese want only the best technology the West can offer.

WEINER CHAMPIONS INVESTING IN JAPAN

TOKYO

Steven E. Weiner has good news for U. S. companies thinking of setting up shop in Japan. The associate representative for the American Electronics Association, deep in the trenches working on the Japanese trade imbalance, says that companies can reap tremendous benefits from investing in Japan. Aside from increasing sales, they can capitalize on incentives such as tax breaks, subsidized employee salaries, and reduced interest rates.

"The Japanese government doesn't really communicate about their investment programs, but they really want the United States to invest in technology parks," says Weiner, who has been working with the AEA in Tokyo since April 1984. Although U. S. technology companies, especially semiconductor concerns, are beginning to realize the sales value of setting up shop in the Pacific, they haven't yet realized the investment value of such moves.

Weiner, 31, tried to enlighten local companies to these facts during a recent home leave in Silicon Valley. "We're trying to trumpet these things while we're visiting. The government provides benefits such as tax holidays, reduced interest rates on loans, reduced land prices, utility rebates on the use of electricity, and cash subsidies for a percentage of employee salaries for a couple of years. The benefits vary by region, but those I've named are standard."

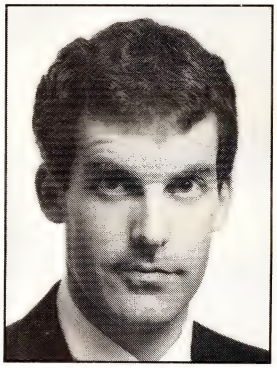
Japanese generosity has a strong element of self-interest, says Weiner. "They have a labor problem." Most technology companies are located in only several major cities. "Right now, labor forces are centered in Tokyo and Osaka. Those cities have drained other places of their labor forces because workers have to travel to the cities to work. In some places, even with 30 employees, a U. S. company could be the largest employer in the region. And its presence would be blessed by the government and the parents of the workers. The manager would be treated like an old feudal lord."

Weiner and senior representative John Stern operate their office under a two-year grant from the Department of Commerce, although the AEA pays their salaries. Their charter is to improve the competitiveness of U. S. companies in the Japanese market.

"You earn lots of credibility by being a trade association in Japan," says Weiner. "Eight or nine trade associations have come to the table to speak to the AEA. Sometimes it's issue oriented—if both sides agree on something, like the unitary tax, for example, they can lobby together to defeat an issue or champion it. If you're the kind of person who worries about a trade imbalance, it can be very exciting."

Weiner's background gives him the knowledge to help right that imbalance. He earned his BA in East Asian languages and cultures from the University of Southern California and his master's at the Thunderbird school, in Glendale, Ariz., also called the American Graduate School of International Management, where he continued his study of Japanese culture.

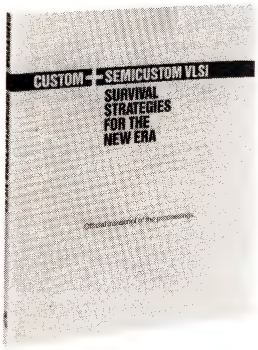
–Denise Caruso



GUNG HO. Steven Weiner says U. S. companies haven't realized the value of investing in Japan.

CUSTOM AND SEMICUSTOM VLSI:

Survival Strategies For The New Era



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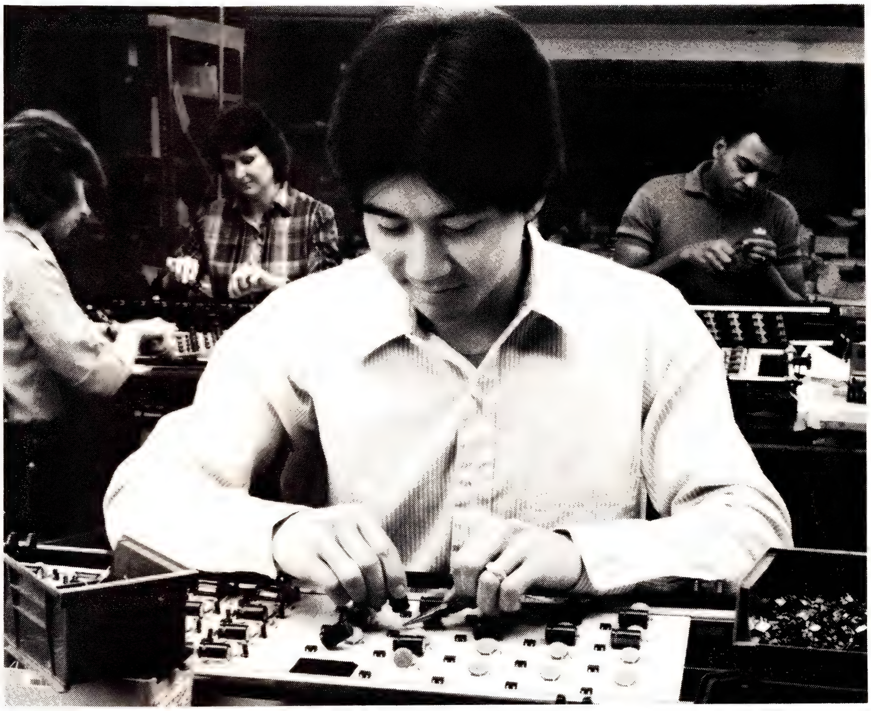

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POWER SUPPLIES GET SMALLER AND MORE RELIABLE

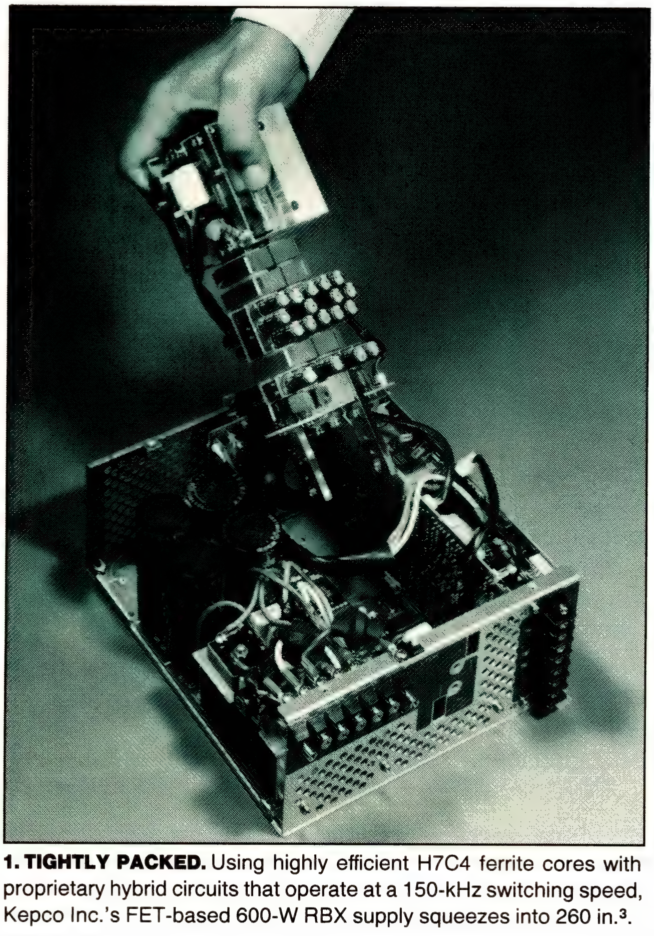
PARTS COUNT IS DOWN AND SWITCHING FREQUENCIES HIT 1 MHz

by Howard Bierman

Advances in components and new circuit techniques are fueling a transformation in the ubiquitous power supply. Today's power supplies are more reliable, smaller, and have significantly greater power densities than their predecessors.

Designers of switching-mode supplies, or switchers, are using surface mounting and custom thick-film hybrids to slash parts count and thus upgrade reliability. For example, one Swedish company, AB Rifa, claims its 20- to 40-W hybrid dc-to-dc converters achieve a mean time between failures of 1.7 million h. Lower parts counts in turn help to lower prices, a trend that also benefits from the intense competition among the more than 500 companies marketing power supplies. Suppliers are turning to off-shore manufacturing and factory automation, and costs are down to less than $1 per watt.

Makers of ac-to-dc switchers are following a steady path to ever-higher frequencies to reduce transformer and filter-capacitor size and thus improve power density. Power densities have climbed to 3 W/in.^{3} for 100- to 500-W ac-to-dc supplies and as high as 50 W/in.^{3} for dc-to-dc converters. These supplies now hit 150 kHz—a considerable gain over earlier 20 kHz designs. Two dc-to-dc converter vendors—Theta-J Corp., Wakefield, Mass., and Vicor Corp., Andover, Mass.—have 1-MHz products.



1. TIGHTLY PACKED. Using highly efficient H7C4 ferrite cores with proprietary hybrid circuits that operate at a 150-kHz switching speed, Kepco Inc.'s FET-based 600-W RBX supply squeezes into 260 in.^{3}.

The move to higher frequencies places responsibility on capacitor manufacturers to lower equivalent-series resistance and equivalent-series inductance, which pose serious obstacles above 100 kHz. These vendors have responded by developing new foil materials and improved etching techniques. For their part, semiconductor manufacturers, in addition to their steady efforts to reduce MOS FET on-resistance, are turning out application-specific integrated circuits for power supplies to handle voltage regulation, soft starting, input/output isolation, and pulse-width-modulation control (see "Basics of switcher operation").

LINEARS LOSING GROUND

Before the advent of solid-state technology, the linear regulated power supply provided the hundreds of volts that vacuum tubes required. Although considerable power losses came from the linear power supply's transformer core and copper as well as from the series-pass regulator, its efficiency exceeded 60% and the need for high-density packaging was not pressing. But with today's incessant demand for smaller, lighter systems, the linear supply has given ground to improved switching-mode designs with efficiencies exceeding 80% and lower cost, except in the under 50-W range. As a result, industry watchers expect market share for linears to drop to 30% by 1989, (see "Power-supply market to hit $9 billion by 1989," p. 45).

Linear supplies have significant drawbacks. For one, they become less efficient when their output voltage is low because transformer losses and rectifier and series-regulator voltage drops become more acute. With a linear supply, the input range within which efficiency is generally unaffected by input line voltage is ±10%. Switchers are only marginally affected by line voltage variations, and thus the acceptable input range can be as wide as 30%. Power density for linear power supplies is about 0.4 W/in.^{3}, compared with 4 W/in.^{3} for off-line switchers. Another significant difference is weight. A typical 600-W linear supply weighs in at 50 lb, occupies 2,000 in.^{3} of space, and dissipates 600 W of heat. By contrast, a 600-W switcher (a series RBX from Kepco Inc.) weighs less than 10 lb, takes up 260 in.^{3} of space, and generates about 100 W of waste heat (Fig. 1).

And although switchers have a slower transient recovery time than linears, they offer the advantage of a considerably longer hold-up time—the duration of time that dc power remains after ac power falls below a minimum set level—which is particularly desirable for computer applications.

Linears do have significant advantages over switchers, however. Linear supplies beat switchers in load and line regulation (see table), although switcher suppliers have started to add linear regulators to their products' auxiliary outputs. Output ripple amplitude from switchers is considerably higher and has the added drawback of appearing as sharp, high-frequency pulses that can create havoc in the form of conducted and radiated interference. Linears are thus the power supply of choice for numerous laboratory applications that cannot tolerate the noisy environment generated by a bench loaded with switching-mode supplies. For some applications, linear supplies are easier to program than switchers. When a system requires a preset series of incremental variations in voltage to be performed within microseconds (as might be required in an automatic test system), engineers generally choose linear power supplies.

Linear power supplies are also easier to design than switchers. In the past few years, however, many original-equipment manufacturers have abandoned in-house design and production of power supplies entirely and turned to outside vendors. An OEM with a limited engineering staff may be hard-pressed to allocate the time and expense for engineers experienced in analog feedback loops, the latest MOS FET design techniques, and the nuances of ferrite magnetics. Power-supply manufacturers, who have seen their ranks swell with a growing number of off-shore companies, acknowledge that it is in their interest to hire and train such specialists.

Another reason many OEMs buy rather than make their own supplies is the increased attention to foreign safety regulations. A decade ago, certification by Underwriters Laboratories Inc. and the Canadian Standards Association were sufficient for a power supply's approved use abroad, and makers paid little heed to European standards.

As interest in the European Communities picked up, OEMs discovered that access to this market depended on compliance with such standards as West Germany's Verband Deutscher Electrotechniker 0806. Acceptance testing for these standards could take up to a year and entail the added expense of hiring an engineer with experience in these safety regulations. Here

BASICS OF SWITCHER OPERATION

Most power supplies sold today are off-line switchers. These convert 115-V ac line voltage to high-voltage dc and then immediately chop the dc into high-frequency square waves ranging from 20 kHz to as high as 1 MHz. The square waves proceed to a high-frequency transformer, then are rectified and filtered to provide the required dc voltage output. Because these supplies operate at 20 kHz or higher, their transformers, coils, and filter capacitors are much smaller and lighter. A control circuit known as a pulse-width modulator (PWM) stabilizes the voltage by varying the pulse duration of the chopped waveform. Expanded pulse widths raise the output voltage, narrow pulse widths generate less dc output.

The two standard types of switchers are boost (or step-up) and buck (or step-down). Boost switchers store energy in an inductor and then deliver it to the load together with energy from the input ac line. Buck designs chop the ac line voltage, filter it, and apply it to the load when the switcher is on. When the switcher is off, energy stored in an inductor or transformer goes to the load. Buck circuits include the forward converter and the center-tapped push-pull arrangement while the popular flyback arrangement is based on the boost concept.

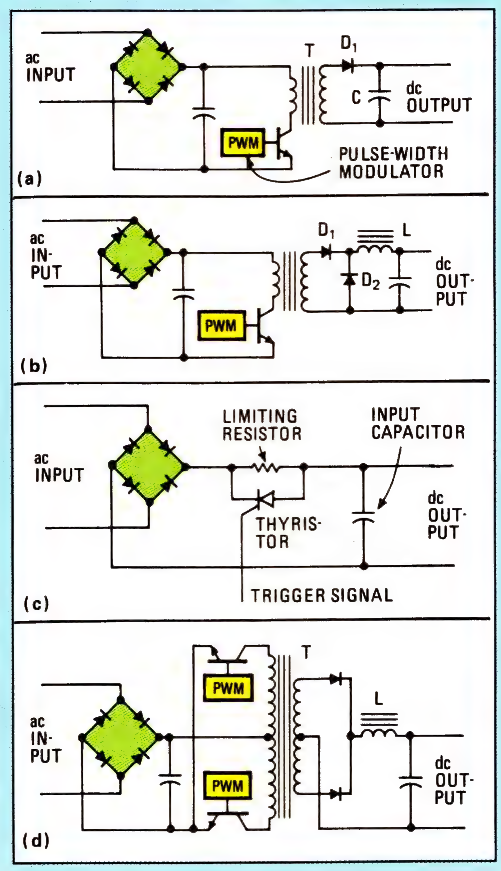
The flyback converter is the most economical design for power supplies under 150 W because of its simplicity and low parts count (a). When switching transistor Q is conducting, current increases at a linear rate through the primary of transformer T, which behaves like an inductor by storing energy in its core. As soon as Q cuts off, the flux in the transformer core decreases, permitting current to flow in the secondary circuit, charging capacitor C as well as feeding the output load. A PWM loop controls Q's conduction by comparing output voltage to a set reference; if the output load demands more current, on-time is lengthened. An off-line flyback circuit uses a bridge rectifier and filter capacitor to convert the line voltage to 150 V dc for the switching section.

Although the forward converter (b) looks like the flyback circuit, there is a major difference: inductor L stores energy rather than transformer T. When the switching transistor is on, current flows through diode D1 and inductor L, with the average current level determined by the duration of the on-time. When the transistor switches off, the inductor cannot change current flow instantaneously, and thus current continues to flow through diode D2 and the output load.

For low-power (below 100 W) applications, the flyback configuration is preferable to the forward converter because it does not require an additional inductor. As current demand rises, however, the size of the single transformer increases considerably, obviating the size and cost advantage. Operating directly off the ac line eliminates the need for an expensive, bulky power transformer but poses a problem of high inrush current to charge the filter capacitors, which had been handled by the transformer primary. A soft-start circuit (c) used with off-line switchers includes a current-limiting resistor, placed between the rectifier and the input capacitor, which is shorted out by the thyristor as soon as the input capacitor is fully charged to reduce power dissipation and improve efficiency.

High-power designs use push-pull converters, including the center-tapped configuration (d), which consists of two forward converters with alternating on-periods. While each converter is on, current flows to the load through the inductor, which is storing energy.

During the brief intervals that neither converter is conducting, the inductor maintains current through the load, thus providing the lowest ripple content of all switching-type designs.



COMPARISON OF LINEAR VS SWITCHING POWER SUPPLIES

Specification	Linear	Switching
Power density	0.5 W/in.^{3}	2.7 W/in.^{3}
Efficiency	40% to 55%	60% to 90%
Input voltage range	±10%	±30%
Line regulation	0.02% to 0.05%	0.05% to 1.0%
Load regulation	0.02% to 0.01%	0.1% to 1.0%
Output ripple	0.5 to 2 mV rms	25 to 100 mV peak-to-peak
Hold-up time	2 ms	32 ms

again, power-supply manufacturers are better equipped than original-equipment manufacturers. And because power-supply designs evolve at a steady rate, it is often possible for power-supply makers to maintain the original design's compliance approval without appreciable delay. Thus OEM customers can avoid lengthy approval delays by purchasing from long-established power-supply manufacturers.

ON-BOARD CONVERTERS

Many OEM systems use a number of circuit boards to drive displays, modems, disk drives, and cathode-ray tubes, each of which require different dc voltages. One approach to power distribution is to provide one or several multi-output power supplies and route the necessary dc voltage to each board. A money-saving alternative is to use a main power supply with a single dc output and feed voltage to individual board-mounted dc-to-dc converters, which will then provide the required dc levels.

Compact dc-to-dc converters with up to 30-W output are now available to serve the needs of low-power CMOS circuitry, and Vicor and Theta-J have recently introduced such units with ratings up to 100 W. Prices for dc-to-dc converters vary from $20 to over $150, depending on power density, number of outputs, degree of regulation, and output isolation. Many converters come in both plastic and hermetically sealed dual in-line packages.

Vendors caution designers against overspecifying dc-to-dc converters for specific applications. A dc-to-dc converter's efficiency is optimized for its full rated load and decreases as load drops. For example, a 6-W converter with 65% efficiency requires 9-W input power; a 12-W model might operate at 55% efficiency to deliver only 6 W and thus require over 10-W input. An overspecified converter demands more input power and could increase a densely populated board's space by as much as 80%.

Similarly, the designer should consider whether the output of the power supply driving the converter is sufficiently stable to negate the need for regulation. Packaging density is higher for converters that do not include load regulation, an acceptable approach if the converter is fed from a regulated dc input. Unregulated converters are not only cheaper than regulated models, their efficiency is generally 10% to 15% higher and reliability is improved simply because of lower component count. Should regulation later become necessary for an existing board, an inexpensive three-terminal postregulator can be added.

For applications requiring high voltage (on the order of 17,000 V dc), such as CRT monitors, Emco High Voltage Co., Sutter Creek, Calif., offers the EHT6147, a fully encapsulated dc-to-dc converter. With an input voltage of 24 V dc, this compact unit delivers 17 kV at 0.4 mA, 1,100 V at 1 mA, and –100 V at 5 mA with dynamic regulation of 0.1% per 0.1 mA load current. The 1.5-lb unit includes a seven-pin connector for I/O wiring and a high-voltage anode connector.

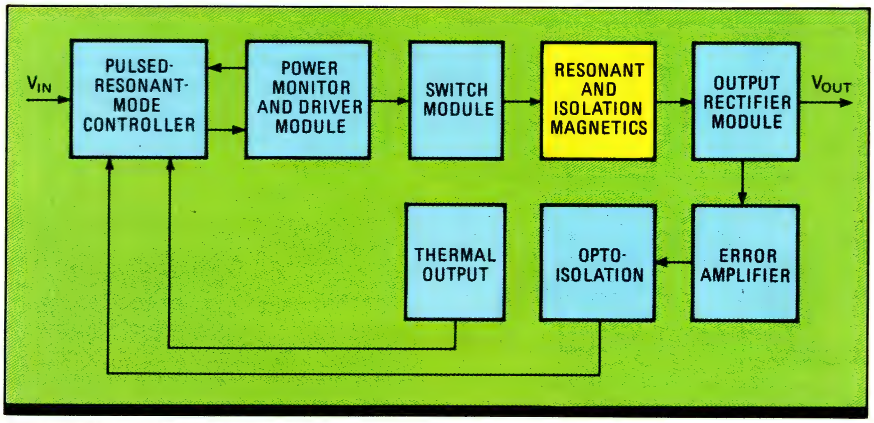
Pushing switching speed up is the key to smaller supplies and higher power densities. However, with today's switching devices, the tradeoff between power density and efficiency hits a limit of 100 kHz for most switch-mode converters. This limitation is due to switching losses: energy is lost each time a switching transistor turns on or off while current is flowing, and losses increase as frequency is raised.

Vicor found a way around this problem. Zero-current switching is a new topology, according to Vicor president Patrizio Vinciarelli. It cuts down switching losses and radiated interference, permitting operation into the megahertz region. Using a magnetizing current mirror arrangement, which Vinciarelli describes as the opening and closing of switching elements in series with inductive and capacitive storage elements, energy can be switched when current is close to zero. Frequency modulation regulates output rather than pulse-width modulation used in conventional switch-mode designs, he adds.

1-MHz CONVERTERS

Vicor's VI 100 dc-to-dc converters operate at 1 MHz, achieving a power density of 51 W/in.^{3} for a 12-V 25-A model and 15 W/in.^{3} for a 5-V 15-A unit. Efficiencies reach 90% depending on output power, Vinciarelli claims, and the unit boasts a calculated MTBF as high as 800,000 h due to the design's low parts count (less than 50).

The VI 100 delivers up to 100 W and operates from 10 to 370 V dc. For larger power needs, the VI 200 delivers up to 300 W. No-load power dissipation is nominally rated at 0.5 W, and the VI provides short-circuit and overvoltage protection as well as current limiting. The VI 100's output doubles to 200 W with Vicor's recently introduced VIB-00 power boosters; when connected in parallel, 10 units can deliver 2,000 W. Based on a charge-pump concept, the booster stores energy in the leakage inductance of a coupling transformer and discharges it through a diode into the load. The charge-pump rate varies from 100 kHz at light loads to 1 MHz at full load.



2. PULSED RESONANCE. Theta-J nears 90% efficiency by synchronously pulsing a power MOS FET at 1 MHz, forcing a primary resonant circuit to ring and send energy to the secondary.

Theta-J claims a power density approaching 30 W/in.^{3} for its Microswitch-mode 1-MHz 130-W converter; its efficiency exceeds 90% (Fig. 2). The company reduced the unit's size by using special turns deposited on the printed-circuit board to serve as transformer windings and a custom large-scale chip to replace seven ICs in the original prototype. Operating from dc inputs ranging from 36 to 72 V, the dc-to-dc converter comes with standard single outputs of 2, 5, 12, 15, or 95 V. Users can stack the 130-W modules to deliver over 1,000 W where required.

Operation is based on a pulsed-resonant-mode (PRM) technique, wherein a power MOS FET is pulsed synchronously to force a resonant primary circuit to ring or oscillate for one cycle, transferring energy to the secondary. Although the concept is not new, early design converters were impractical because of drive circuit complications and the speed limitations of bipolar devices, which Theta-J replaces with power MOS FETs.

The Theta-J Microswitchmode uses a thermal design that affixes all heat-dissipative elements (core materials, primary-side switch module, and secondary rectifiers) to the metal baseplate through insulators having specific thermal resistance. This, Theta-J engineers state, enables the use of Schottky rectifiers, so the design tradeoff of lower drop versus leakage can be shifted to achieve a very low rectifier drop with an immediate improvement in efficiency. The converter includes a power monitor IC that handles inputs as high as 300 V.

The PRM driver IC acts as the system clock, producing a frequency-modulated signal up to 1 MHz. This signal, after amplification, goes to a power MOS FET switching circuit. When the MOS FET switches on, the resonant magnetic circuit rings and is synchronized with the system clock. Energy transfers to the secondary circuit through a high-frequency isolation transformer normally rated to withstand 1,500 V. The transformer winding is of special construction to handle such critical factors as interwinding capacitance and skin effects at 1 MHz. For example, in the 5-V model, a single-turn secondary is precisely formed to achieve maximum energy transfer. Although achieving radio-frequency radiation at multiple harmonics of 1 MHz was a challenge, Theta-J designers claim the suppression techniques used to accomplish the necessary filtering were quite straightforward and no unusual solutions were required.

POWER-SUPPLY ICs PROLIFERATE

This year, chip makers introduced a wide variety of ICs for power-supply control, regulation, isolation, and soft starting. The chips' advantages over their discrete and hybrid counterparts for high-volume users include lower cost, improved regulation, overvoltage and overtemperature control, higher power density, and performance in the 1-MHz switching-frequency range. The offerings include a family of three chips for linear power-supply designs, linear regulators, input-isolation circuits, and soft-start chips.

Three ac-to-dc converter chips from Maxim Integrated Products Inc., Sunnyvale, Calif., include rectifiers and regulators and operate directly off 115- or 220-V ac power lines. These ICs deliver 5 V dc at up to 50 mA, complete with series-pass

POWER-SUPPLY MARKET TO HIT $9 BILLION BY 1989

Like other sectors of the electronics industry, the U. S. power-supply market has been hard hit by 1985's collapsing sales for microcomputers and peripherals. Coming off a total market of close to $4.6 billion in 1984, U. S. consumption of power supplies in 1985 will be flat or slightly lower, say most industry observers and forecasting firms such as Salzer Technology Enterprises Inc., Santa Monica, Calif., and Frost & Sullivan Inc., New York. But they expect a turnaround after 1985 with brisk sales bringing the total market up to $9 billion by 1989.

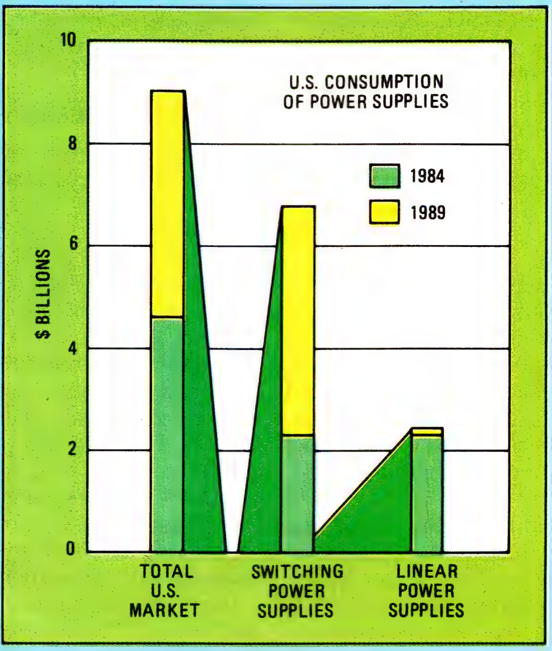
Roughly two thirds of the market belongs in the captive category, as many large computer and systems houses build their own power supplies. This still leaves over $1.5 billion for merchant vendors. Some 15 to 20 major players own more than 80% of this share, with over 500 smaller companies battling for the remainder. The intense competition, which now includes newcomers from the Far East, together with the slack in demand have continued to erode prices to 60¢ to 75¢ per watt for low-power switches (150 W and under) and 85¢ to $1 per watt for higher-power units (150 to 1,000 W).

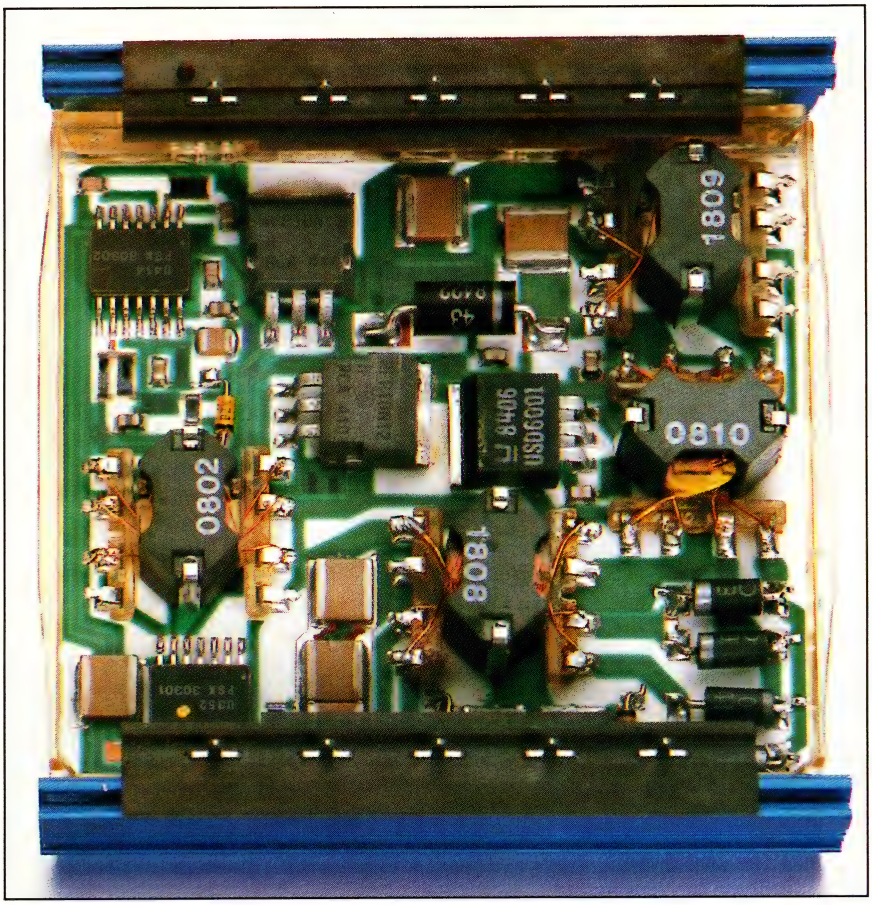
Conventional series-passing linear power supplies are steadily losing ground to smaller, lighter, and more efficient switchers. Linears are expected to hold slightly more than 40% of the total 1985 market, with their portion projected to drop to 30% by 1989. Even at power levels under 100 W, where linears offered a cost-performance advantage, switchers have been aided by innovative flyback converter designs that have cut parts count and assembly time, and thus costs. Today, for example, a 40-W linear power supply with three output taps sells for about $1.25 per watt, versus $1 per watt for a similar switcher. But linear power supplies have one edge over switchers that ensures their continued presence—programmability.

Switchers are often divided into three groups: low power (150 W and under), medium power (150 to 500 W), and high power (above 500 W). Roughly half of all switchers sold are for low-power, low-cost applications—personal computers, home entertainment goods, and computer peripherals—and this segment is also the most volatile.

Medium-power switchers—to power computer-aided-design and -manufacturing equipment, point-of-sale systems, office-automation hardware, and automatic test equipment—make up 37% of the market. The remaining 13% comprises the 500-W plus units—the smallest growing segment of the market but also the least troubled by offshore competition.

An increase by computer designers in the use of high-speed, high-current emitter-coupled-logic circuits has added some impetus to high-power switcher sales. The high-power switcher market could increase at an annual 19% rate from 1982 to 1987, according to a recent study from Gnostic Concepts Inc., San Mateo, Calif. Computer vendors accounted for a whopping 88% of the high-power market in 1984, with the communications industry picking up 4% and military customers 6% of these switchers.





3. 200-YEAR MTBF. Rifa's thick-film hybrid approach uses ceramic chip capacitors on alumina substrates. The company's dc-to-dc converters have an MTBF of 1.7 million h.

regulation and overvoltage and undervoltage protection. The basic chip, MAX 610, has an internal full-wave rectifier and CMOS series regulator-zener diode configuration. It delivers 5-V regulated dc output complete with overvoltage and undervoltage protection. The MAX 610 does not include a transformer, thus the dc output is not isolated from the ac line.

Isolated 5-V output with the MAX 612 chip requires an 8-V root-mean-square transformer. The MAX 611, intended for triac control systems, has a reset delay pin to adjust the delay of a monostable timer controlled by the chip's overvoltage/undervoltage circuit. Both the 611 and the 612, unlike the MAX 610, include half-wave rectifiers rather than full-wave. All three ICs need three external components to complete their circuitry—an input current-limiting capacitor and resistor plus an output filter capacitor.

OPTOCOUPLING ALTERNATIVE

Optocoupling to isolate the power supply's dc output from the ac line is satisfactory but suffers from sensitivity to temperature variations. The UC 1901 chip from Unitrode Integrated Circuits, Merrimack, N. H., contains a 5-MHz internal oscillator, so a small transformer or capacitor can achieve the required isolation. The IC provides a fast-acting feedback loop between the primary and secondary to sense and compare the dc output voltage and responds quickly to accomplish line and load regulation.

A soft-start chip from Silicon General Inc., Garden Grove, Calif., reduces startup current to less than 1 mA to prevent a switching power supply from burning up fuses or switching devices. The SG1540 includes a comparator-power switch to isolate the start-up capacitor from the load, a high-frequency oscillator to drive an isolation transformer, and another comparator with a crowbar circuit to handle overvoltage.

Power-supply manufacturers are also designing chips. The Lambda Electronics Division of Veeco Instruments Inc., Melville, N. Y., uses a proprietary custom IC control circuit to replace 40 discrete components in their 200-W switches. In addition to reducing parts count, Lambda claims, the circuit layout provides high thermal efficiency. Both features combine to improve MTBF.

Switcher manufacturers are also using surface-mounted devices to boost reliability. But most designers place SMDs on pc boards that are later added externally to the power supply, claims Frank Sposato, marketing vice president at Todd Products Inc., Brentwood, N. Y. He says Todd integrates SMDs exactly where they are functionally required in the power-supply design.

Todd's design uses a modified self-driven half-bridge converter to independently control the switching transistors' pulse width. This technique compensates automatically for transistor, rectifier, or load imbalances and reduces transformer-core saturation and transistor failures. Todd also shrinks the size of the switching-mode output filter section with the proprietary Dynaflux magnetics design, which uses the fringe flux generated in two closely coupled, wide-air-gap, soft ferrite cores to achieve flux cancellation. By combining SMDs with compact Dynaflux chokes, the open-frame 220-W switchers are 20% smaller than equivalent models produced by competitors, Todd claims.

Rifa opted for thick-film hybrid technology and a 300-kHz switching frequency to achieve power densities of almost 4 W/in.^{3} and efficiencies as high as 85% in their line of 20- to 40-W dc-to-dc converters. Operation with power MOS devices at 300 kHz eliminated the need for electrolytic or tantalum capacitors in the design, so lower-failure-rate ceramic chip capacitors take care of the filtering. Rifa took the thick-film hybrid approach to take advantage of the alumina substrate's thermal conductivity and surface-mounted the switching devices (Fig. 3).

POWER FOR PERIPHERALS

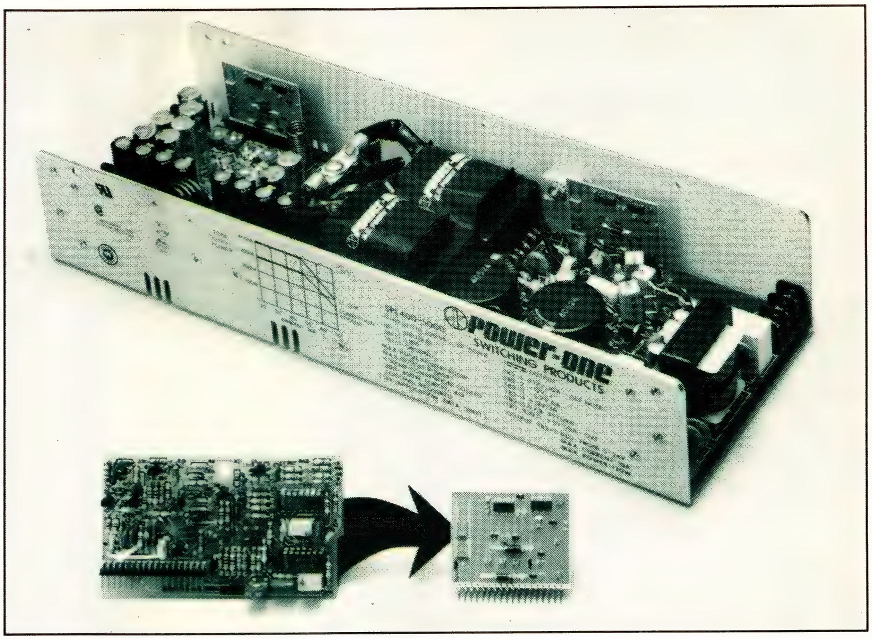
The design sharply reduces thermal stress on components thus and boosts reliability; Rifa's units boast an MTBF of 1.7 million h (over 200 years) at 45°C. To overcome the two-to-one cost penalty of thick-film hybrids over conventional components in pc-board production, Rifa created a surface-mounted hybrid line, including pick-and-place robots, automated laser trimming, and 100% unit testing at the last step of the manufacturing process.

Two custom hybrid circuits in Power-One Inc.'s 400-W multiple-output switching power supplies replace more than 165 discrete components and reduce overall package size by 20% (Fig. 4). Designed for powering CRT monitors, disk drives, and printers, the SPC 400 series offers 2-W/in.^{3} density with the 400-W fully regulated output distributed over five separate outputs. The Camarillo, Calif., company's products operate from 90 to 264 V ac, 47 to 63 Hz, and meet all U. S. and international safety standards.

Overvoltage protection is often mandatory for 5-V switchers that power TTL circuits, which cannot survive excursions beyond 7 V. In linear power supplies, a somewhat higher voltage than required goes through a series-pass dropping semiconductor before reaching the load. The series-dropping part either absorbs any substantial load swing or, in worse-case conditions, burns out, protecting the output load. With a switcher, however, loss of the control feedback loop will increase pulse width to its maximum value and thus create a serious overvoltage situation.

A basic overvoltage protection circuit includes a voltage reference comparator circuit and a silicon controlled rectifier; generally, a zener diode acts as a reference as well as comparator. During normal operation, the SCR is nonconducting. When an overvoltage occurs, however, a signal from the comparator triggers the SCR, causing it to act as a short circuit and draw excessive current to cause a fuse or circuit-breaker to open. Such an arrangement, called a crowbar, is commonly used in switcher designs.

Another overvoltage-protection arrangement makes use of a sensor circuit that simply cuts off the switching oscillator as soon as it detects excessive voltage. Although this design is relatively inexpensive, it suffers from wide variations in trip voltages as well as from temperature instability.



4. TWO REPLACE 165. Power-One Inc. achieved a space saving in package size of over 20% by replacing 165 discrete components on a pc board with two thick-film hybrids.

Motorola Semiconductor Products Inc., Phoenix, Ariz., recently introduced a single-chip overvoltage and overtemperature product combining MOS and bipolar technologies. The chip dissipates very little quiescent power, permitting the junction and case temperature to be nearly equal. If a thermal sensor is used on a heat-sensitive area, such as the housing of a transformer or rectifier diode package, any increase in case temperature above a certain limit will trigger the chip's onboard SCR, removing the power from the output load. A simple voltage-divider network can set the trip-point voltage to a specific value; such an arrangement also offers the ability to program a variety of trip voltage levels or remotely trigger the SCR.

MOVING TO 1-MHz SWITCHING

Motorola's 0.182-in.^{2} chip contains 36 MOS FETs, 4 bipolar devices, 12 resistors, 2 capacitors, and a MOS-gated power SCR. The SCR's anode and cathode connect across the power bus of the pc board that the chip is assigned to protect. The SCR will crowbar the power-line bus if the monitored temperature exceeds 125°C or if the bus voltage rises above 6.2 V.

Passive-component makers also deserve much credit for advances in power density, efficiency, and cost reductions in power supplies. Moving from the conventional 60-Hz line frequency as the power-supply input to switching frequencies up to 1 MHz offers a tremendous opportunity to reduce the size and weight of transformers, filter capacitors, and chokes. Since higher frequencies permit the power supply's passive components to store less energy before transfer to the load, their capacitance and inductance ratings can be dramatically lower than their 60-Hz counterparts. But higher-frequency operation places a new burden on suppliers of filter capacitors, switching transistors, and rectifiers. Parameters such as leakage inductance and parasitic capacitance become critical for inductors and transformers, while equivalent-series resistance and equivalent-series inductance become significant capacitor considerations.

Sprague Electric Co., North Adams, Mass., developed two capacitor designs tailored for switchers. The first is an aluminum electrolytic capacitor for operation at 100 kHz and lower. The second, a solid tantalum device in a 16-pin DIP, is for 100- to 300-kHz operation. The rectangular aluminum electrolytic component houses an extended foil with its turns shorted to minimize parasitic inductance. Impedance is on the order of 10 Ω at 100 kHz, and the parts come rated at 6.3 to 200 V.

Improvements in foil material and etching have shrunk the size of luminum electrolytic capacitors by as much as 80%. Etching aluminum foil produces pits along the surface that form the electrode area. Dc etching is now giving way to ac etching for low-voltage electrolytic capacitors because it is more efficient and produces 80 times more foil surface. High-voltage capacitors (over 100 V) still require dc etching, however, because of the excessive heat buildup generated by the ac process. One capacitor manufacturer, Mepco Electra Inc., Morristown, N. J., uses a combination ac- and dc-etching process it claims increases surface area by a factor of 100 over dc etching. Using the new fabrication process, Mepco reduced the height of its computer-grade 600-mF 5-V capacitor from 5.625 in. to only 3.625 in.

Thanks to higher-quality foil, closely guarded electrolytic chemical compositions, and tightly controlled manufacturing steps, capacitors can operate at higher temperatures. The common rating for commercial-grade capacitors has jumped from +85°C to +130°C and higher. Most systems will not demand this operating temperature, but capacitor vendors claim these upgraded components will provide a longer and more reliable operating span at cooler temperatures.

OPERATING AT –55°C

Although polycarbonate capacitors cost four times as much as aluminum electrolytic types for the same capacitance and voltage rating, they operate more efficiently at temperatures as low as –55°C and carry five times more ripple current without breakdown. In addition, film capacitors can withstand 200% overvoltage spikes and 100% voltage reversals, compared with 130% overvoltage stress and only 1-V maximum voltage reversals for electrolytics. Polycarbonate plastic has a higher dielectric constant than polypropylene. Thus it offers a substantial size advantage; 50-V polycarbonate capacitors can be half the size of comparable polypropylene capacitors. Finally, for switching power supplies that must operate over the –55°C to +125°C military range, metallized film capacitors meeting MIL-C-83421 reliability standards for hermetically sealed capacitors are readily available. □

TECHNOLOGY TO WATCH

A NEW MASK COULD FINALLY OPEN UP X-RAY LITHOGRAPHY

MICRONIX'S ADDITIVE PROCESS SOLVES RESOLUTION, YIELD PROBLEMS

TECHNOLOGY TO WATCH is a regular feature of *Electronics* that provides readers with exclusive, in-depth reports from companies around the world on important technical innovations. It can cover significant technology, processes, or developments incorporated in major new products. The reports will also provide analyses of technical data so that readers can assess the impact of new developments. Alex Shimkunas and Philip Mauger of Micronix Corp. were responsible for the development of Micronix's additive mask technology

X-ray lithography—a process for imaging a full-field mask onto a wafer by using X rays of extremely short wavelength—may now finally make its long-awaited move out of the laboratory and onto the production floor. A new additive mask-making process could hasten this move by overcoming many of the disadvantages of present techniques.

Current subtractive methods, which etch away metal to form mask patterns, are unable to turn out vertical wall profiles, which severely limits resolution. Just as important, throughput and yields with this approach are notoriously poor.

Now Micronix Corp., Los Gatos, Calif., has developed an additively patterned mask that will allow X-ray lithography to advance deeper into the submicron domain. Its mask technology provides several advantages:

- Features can be resolved to better than 0.5 μm, because its technique creates vertical wall profiles on a finished mask's pattern.
- The additive process inherently has a much higher throughput than subtractive techniques.
- Patterning temperatures and absorber stress are both much lower, which helps to improve mask yields.

X-ray lithography has long been touted as the technology needed to overcome the limitations of optical and electron-beam lithography in the move to submicron features. The primary advantage of X-ray lithography is its high-image resolution, thanks to the short wavelength of the X rays. It is not affected by either depth-of-focus problems or by the reflection and scattering effects that plague optical and electron-beam lithographic techniques. And X rays offer high aspect ratios and transparency to particulates that produce mask and wafer defects with other approaches.

Of all the problems that confront X-ray lithography, mask making has been the stickiest. A mask must be distortion-free and capable of being patterned to submicron dimensions. Alex Shimkunas, mask-development manager at Micronix, notes that his company's commercial X-ray lithographic system depends on the last decade's developments in X-ray mask technology. Little of this technology could be spun off from optical-lithography mask-making, because these two methods require significantly different materials and designs. Glass substrates provide high transparency to ultraviolet light, but only thin membranes (thinner than 10 μm) of materials having low atomic number are transparent to X rays with wavelengths smaller than 10 Å.

Most X-ray mask blanks are made of a thin-film membrane structure supported around its periphery by a ring. The membrane, which is held in tension to keep it flat, is transparent to X rays and acts as a substrate for the X-ray absorber pattern that blocks the X rays. It can be either a single or a multilayer structure, and it must have a high tensile strength to keep it from fracturing under the tension.

The most useful X-ray mask blanks have been made by depositing the membrane material by vapor deposition on a host substrate, which is then back etched. The most common membrane material is boron nitride, whose membrane thickness is typically 3 to 6 μm. This material is deposited by low-pressure or plasma-enhanced chemical-vapor deposition on silicon substrates. The resulting film is a hydrogenated, amorphous form of boron nitride. Other materials that have successfully formed membranes include silicon nitride and silicon carbide. Micronix uses boron nitride. The membrane is usually coated with a polyimide layer, which strengthens the structure as well as planarizes the surface.

Absorber patterns on an X-ray mask can be gold, tantalum, or tungsten. Gold absorbers can be patterned by either subtractive or additive techniques. Until recently, subtractive patterning was almost exclusively used for making masks because of the problems of electroplating in the additive process.

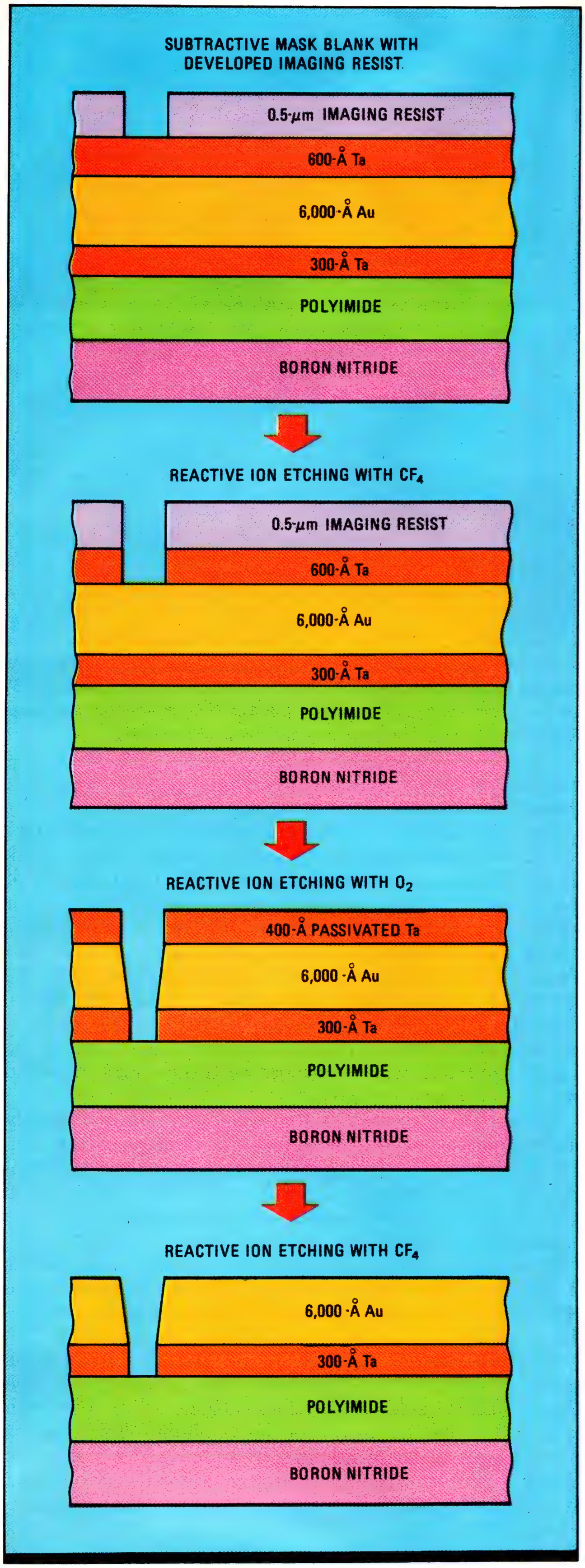
SPUTTER-ETCH THE GOLD

At Micronix, a typical subtractive patterning process (Fig. 1) consists of sputter-etching the gold absorber layer using a thin metallic layer such as tantalum as the etch mask. For this process, the mask blank is first coated with a multilayer absorber—a sandwich of Ta, Au, and Ta. The bottom tantalum layer is 300 Å thick and serves to promote adhesion of the gold and acts as an etch stop. The middle gold layer, typically 6,000 Å thick, forms the absorber pattern. The upper tantalum layer, about 800 Å thick, serves as the etch mask.

These metallic layers are coated with an appropriate resist layer, which is exposed and developed using standard techniques. The resist pattern is transferred to the upper tantalum layer by reactive ion etching, using carbon tetrafluoride as the process gas. The patterned tantalum layer now serves as the etch mask for pattern transfer to the gold layer.

The gold absorber is patterned by sputter etching in a mixture of argon and oxygen. The presence of oxygen in the sputtering gas increases the sputter-etch selectivity of the gold over tantalum by decreasing the tantalum sputter rate. The bottom tantalum layer is the etch stop. The final step in the patterning process is the removal of the bottom tantalum layer in the pattern spaces by reactive ion etching in carbon tetrafluoride.

Because of redeposition of the sputtered material, the subtractive patterning leaves gold features with a characteristic wall angle of about 70°. This angle limits the minimum width achievable for a given absorber thickness. And because X-ray absorption is an exponential function of the gold's thickness, a resist-coated wafer exposed to a sub-



1. SUBTRACTIVE PATTERNING. In subtractive patterning of an X-ray mask, the gold absorber layer is sputter-etched using a thin layer of tantalum as a mask. The process's steps start with electron-beam imaging and end with the finished gold pattern.

tractively patterned mask receives a graded exposure dose under the sloped portion of the absorber. This effectively limits the feature sizes possible with subtractive masks to greater than 0.5 μm. To provide higher resolution and line-width control, the wall profiles of the gold absorber must be made nearly vertical. "Such profiles can be achieved using additive patterning techniques in which gold is electrodeposited into a resist stencil to form the absorber pattern," says Shimkunas.

In the Micronix additive patterning process, gold is electroplated from a commercial plating solution. A three-level resist stencil over a three-level plating base creates a vertical wall stencil for electroplated pattern formation (Fig. 2). The upper layer of the three-level resist is the initial imaging layer. This can be a standard photoresist; it is imaged and developed with electron-beam patterning techniques. For this application, a resist with a dry-etch resistance in fluorocarbon plasmas is desirable.

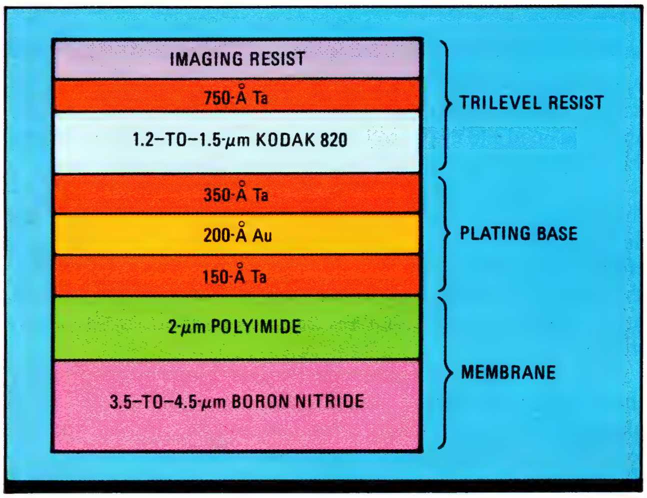
The intermediate layer of the three-level absorber, which consists of 750 Å of tantalum, transfers the imaged pattern to the base polymer level with high selectivity when dry etched in an oxygen plasma. The tantalum layer backscatters electrons during electron-beam imaging, permitting a reduced electron-beam dose.

HIGH-TEMPERATURE BASE

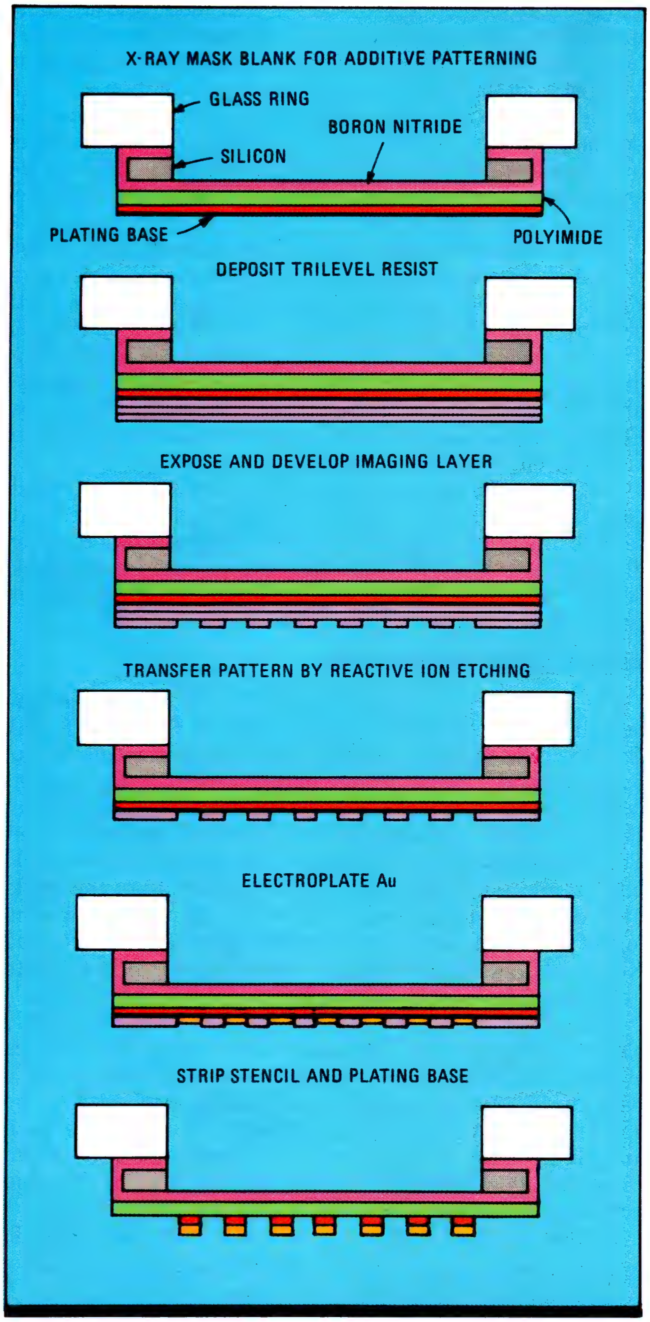
The base layer of the three-level resist is a high-temperature material, such as polyimide or Eastman Kodak Co.'s 820 resist, that can be etched anisotropically in an oxygen plasma. The high temperature resistance is important because the material must withstand heating during the subsequent sputtering of the deposited tantalum layer. The base-resist layer serves as the stencil for the gold plating and must have a thickness greater than the thickness desired for the gold absorber to prevent mushrooming of the gold sidewalls. Micronix has successfully used Kodak 820 resist between 1.2 and 1.5 μm thick to plate gold patterns up to 1 μm thick.

The plating base is a thin conductor upon which the gold electrodeposit grows. The top 350-Å tantalum layer serves a critical function in that it preserves a clean and flat gold base during the patterning of the three-level resist. The sputtered 200-Å gold layer provides the conductive path and plating base for the electrodeposited gold. The bottom 150-Å tantalum layer provides adhesion between the gold base and the polyimide/boron nitride membrane.

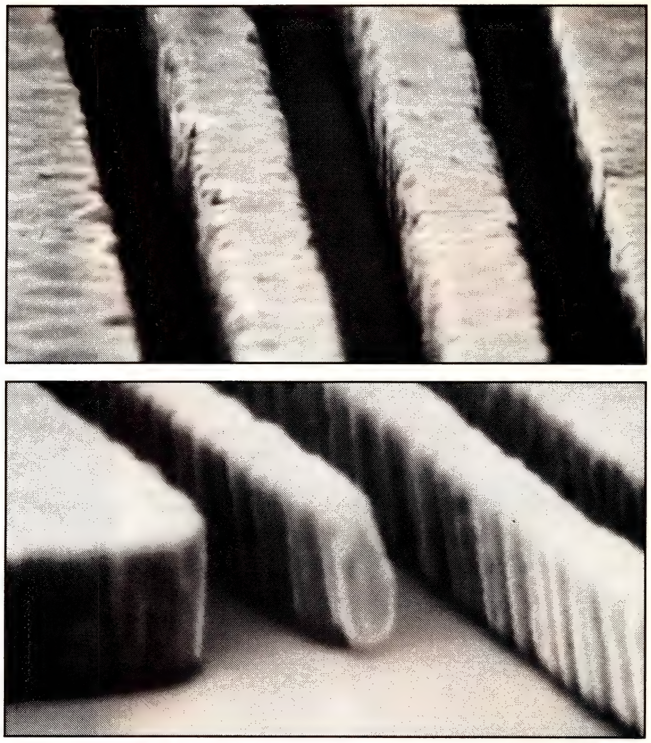
In the complete additive mask patterning flow (Fig. 3),



2. MULTILEVELS. An additive mask blank structure consists of a three-level resist sensitive to electron-beam imaging, a three-layer plating base to aid electroplating, and a thin polyimide and boron nitride membrane to support the desired gold absorber pattern.


X-RAY MASK BLANK FOR ADDITIVE PATTERNING
GLASS RING
BORON NITRIDE
SILICON
PLATING BASE
POLYIMIDE
DEPOSIT TRILEVEL RESIST
EXPOSE AND DEVELOP IMAGING LAYER
TRANSFER PATTERN BY REACTIVE ION ETCHING
ELECTROPLATE Au
STRIP STENCIL AND PLATING BASE

3. THE ADDITIVE WAY. The additive mask flow is completely different from subtractive mask processing. After an image has been exposed and developed into the trilevel resist, this pattern is transferred to the thick layer of Kodak 820, forming a stencil for electroplated gold.



4. SUBMICRON MASKS. Additive masks with vertical sidewalls are ideal for submicron lithography. The mask shown at the top has 0.75-μm lines and spaces; the lower mask has 0.5-μm lines and spaces. These results would be difficult to achieve subtractively.

the top layer of the three-level resist is first imaged and developed. Next, the resist's tantalum layer is reactively ion-etched. Then reactive ion etching in oxygen transfers this pattern to the base-resist layer. Following this step, reactive ion etching removes the intermediate layer of the three-level resist.

Then the gold absorber pattern is electroplated using the Kodak 820 resist stencil. The sidewalls of the gold plating follow the structure of the stencil, and so vertical sidewalls are possible. Micronix uses BDT 200, a commercially available gold electrolyte solution from Sel-Rex Plating Systems. The Kodak 820 resist stencil is removed by reactive ion etching in oxygen, followed by removal of the plating base by reactive ion etching in carbon tetrafluoride in the areas that are not electroplated. The completed mask is top-coated with polymethylmetharylate to increase the contrast during X-ray imaging.

The electroplating operation step in additive mask fabrication has two advantages, both of which lessen mask distortion. Because mask distortion is the major source of mask rejection, these advantages contribute to the higher yields of additive mask making.

The first advantage of the electroplating step is that electroplated gold has lower internal stresses than the sputtered or evaporated gold used in subtractive masks. The internal stress of the absorber pattern is critical: it must be small enough not to cause local distortions in the membrane that in turn cause errors in the image projected onto a resist-covered wafer.

The second advantage is that this operation is relatively cool compared to the temperature rise during sputter etching of a subtractive mask. Again, the lower the temperature, the less stress on the mask membrane. Micronix is now cooling its mask membranes during the subtractive mask-making process.

Additive mask processing has an inherently higher throughput than does subtractive processing because the electroplating patterning step takes only minutes. Subtractive transfer, on the other hand, takes several hours.

Micronix has now made additive X-ray mask features as small as 0.5 μm in a 1-μm layer of gold (Fig. 4). The almost vertical sidewalls of these masks allow resolution even better than 0.5 μm. It is the resolution limitations of current electron-beam lithography that restrict Micronix's ability to pattern even finer masks, because electron-beam lithography is used to expose a pattern onto a resist-covered mask blank. "Additive patterning with gold looks like a good bet to replace subtractive techniques for gold patterning on X-ray masks," says Shimkunas.

Micronix will soon offer additive X-ray blanks in 4-in. diameters. Additive masks made on Micronix additive substrates are being evaluated at several beta sites. ☐

SEPTEMBER 16, 1985

PRODUCTS NEWSLETTER

TEKTRONIX TO MAKE MAJOR MOVE INTO COMPUTER-BASED INSTRUMENTS

Look for Tektronix Inc. this week to unveil a product it expects will signal the beginning of the end for rack-and-stack automatic test equipment based on the IEEE-488 bus. At an analysts' meeting last week, the Beaverton, Ore., company's Computer-Based Instrumentation unit will describe a system based on instrument cards that plug directly into the VMEbus. The entire system is structured around a 68010-based computer and accepts standard Eurocard elements that could come from third-party vendors. For openers, Tektronix will supply three such instrument cards, each carrying a 68010. The cards turn the system into a digitizer, a pattern generator-word recognizer, and an arbitrary waveform generator. ☐

$4,500 SYSTEM TRANSMITS TV IMAGES OVER STANDARD PHONE LINES

Widcom Inc. has built its 56-kb/s videophone codec into a personal-computer-based system that stores video images and transmits them over phone lines. The Rapics 500 produces an NTSC signal that can be stored on a disk and sent to a color printer. It will accept a color image sent from a remote system and paint it on a TV monitor in 10 seconds, the Cupertino, Calif., company says. The Rapics project was partly funded by General Electric Information Systems Co., Rockville, Md. Both GE and Widcom will market the Rapics 500; a basic system sells for $4,500. ☐

BUILDING A PC AT COMPATIBLE WITH ONE THIRD FEWER ICs

Chip sets to reduce the parts count in computers compatible with IBM Corp.'s Personal Computer/XT and PC AT are the first products from Chips & Technologies Inc. The Milpitas, Calif., company has samples available of a five-chip set called the PC-AT Compatible Chipset that reduces the count on a PC-AT-compatible motherboard from 94 to 36 chips. The four-piece Enhanced Graphics Chipset performs processing, driver, and buffer functions to reduce chip count from 76 to 32 on an XT- or AT-compatible enhanced graphics card. Volume production will start by year-end. ☐

SUN WORK STATIONS ARE TWICE AS FAST AS VAX-11/780

Sun Microsystems Inc. has started shipments of its new Sun-3 line, which it claims achieves twice the speed of a Digital Equipment Corp. VAX-11/780. Color and monochrome work stations in the Mountain View, Calif., company's line couple Motorola's 68020 microprocessor with an MC68881 floating-point coprocessor in a 32-bit VMEbus-based architecture. Stations range in price from $31,900 for a color unit to $12,900 for a desktop monochrome system. All come with 2 megabytes of main memory. An optional accelerator board speeds up floating-point functions to four times the rate of the 68020-68881 combination—achieving the performance level Sun claims. The board sells for $4,900 and will be shipped in early 1986. ☐

HP's BOARD TESTERS OFFER PAINLESS UPGRADE

Four in-circuit board testers from Hewlett-Packard Co. give users the option of reconfiguring the $163,000 entry-level 3065 CL/HL test station to make it identical to the CX/HX, which sells for $237,000. For high throughput, the top-of-the-line 3065 CX/HX can support up to three of the Palo Alto company's HX test stations and up to 14 programming/repair stations. The 3065 CL/HL supports one HL test station and up to three programming/repair stations. Other models are aimed at companies testing low volumes of complex digital and analog boards or high volumes of digital boards. ☐

PERKIN-ELMER TRIPLES THE SPEED OF ITS PARALLEL PROCESSOR

TOP OF THE LINE RUNS AT SIX TIMES THE SPEED OF A VAX 8600

FASTER. Parallel computers use tightly coupled shared memory and two blocks of cache.

The highest-performing parallel-processing computer to date from Perkin-Elmer Corp. uses a processor that is three times faster than the current generation of Perkin-Elmer single and multiprocessor superminicomputers. Thus one six-processor 3280MPS system performs at six times the speed of a Digital Equipment Corp. VAX 8600 at comparable cost.

The 3280's proprietary CPU building block was made faster by extending the instruction set, adding a four-stage pipeline, speeding up the memory-management hardware, and installing a dual cache memory—8-K bytes each for instructions and data. The 3280's software and I/O subsystem are compatible across the company's line of 32-bit parallel-processing systems, says Richard P. Donnelley, product line manager for high-performance systems in Perkin-Elmer's Data Systems Group, which unveiled the 3280 last week.

TIGHTLY COUPLED. The 3280MPS is a tightly coupled shared-memory multiprocessor system, meaning that all processors share one main memory through a fast memory bus and one copy of the operating-system software. The company's OS/32 operating system has a number of support functions for parallel processing, including overall system-resource management, load leveling and queue management, intertask communication, and system-control hooks from high-level languages.

Besides communicating through the shared memory, tasks also talk to each other through direct hardware links. Using 256-K RAMs instead of 64-K parts, Perkin-Elmer can pack 16 megabytes and a controller on a single memory board.

This system simultaneously supports two control environments for parallel processing. The operating system supports both user-transparent and user-directed multiprocessing, says Andy Wax, software senior specialist for high-performance systems.

In the former, the user does not decide which processor will run which job. All jobs are assigned to a single execution queue. Part of the operating system's task scheduler runs in each processor to handle this automatic scheduling. This type of multiprocessing control is suited for jobs that include many small programs. In this environment, user-transparent scheduling provides the best workload throughput in the smallest amount of time.

In user-directed multiprocessing, the user can optimize the parallel processing by tuning it for a particular application. For example, the user may set up multiple queues, decompose the complete job into sub-jobs, and sequence these so that as many as possible run in parallel, taking into account the data dependencies among them. Data dependencies mean that one sub-job may require data that is calculated by another sub-job and therefore the former cannot run until the latter is completed.

Perkin-Elmer software engineers added extensions to the Fortran language run-time library to give users the ability to control task distribution directly through statements in high-level-language programs.

The 3280MPS systems are available for delivery in 120 days. A system with a single processor will sell for $250,000 (about the price of one DEC VAX 8600 system); each additional processor adds $120,000. *–Tom Manuel*

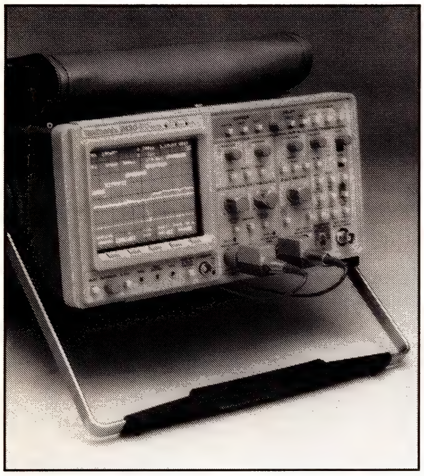
Perkin-Elmer Corp., Data Systems Group,
2 Crescent Pl., Oceanport, N. J. 07757.
Phone (201) 530-5900 [Circle reader service number 338]

DIGITAL STORAGE SCOPES BREAK $10,000 BARRIER

Tektronix Inc. is reaffirming its commitment to basic instrumentation with a complete family of three portable digital storage oscilloscopes. All boast high operating bandwidths, the ability to capture fast-changing phenomena, and a choice of system interfaces.

At the line's top end is the $8,900 model 2430, a 150-MHz instrument, followed by the 2230 at 100 MHz, which sells for $5,150, and the 2220 at 60 MHz, for $4,150. Tektronix does more than break the $10,000 barrier that kept many customers from making the move to digital. It also has incorporated features that had been found only on analog scopes.

The 2430 comes with an IEEE-488 interface bus; the other two offer a choice of RS-232-C or IEEE-488 connections. The communications options are a significant advantage because instruments



GOTCHA. Short 2-ns glitches are easily captured with Tektronix' model 2430 scope.

are starting to be seen as components within larger analysis systems. Through the connections, stored waveforms can be transferred to a computer for more in-depth analysis. And conversely, computer-generated waveforms can be transmitted to the oscilloscopes for reference and comparison with incoming signals.

With the models, Tektronix is going after what Richard L. Knight, general manager of the Portable Instrument Division, sees as three distinct market segments—high performance, general purpose, and low cost. The market for digital storage scopes is growing at 40% a year, Knight says, compared with a growth rate of just 8% to 13% when both analog and digital scopes are considered together. He expects this year's market to be about $1 billion.

The Tektronix models provide two channels, have an 8-bit vertical resolution, signal averaging, and a roll-scan mode (in which the signal is displayed as it is captured), vertical and horizontal waveform expansion or compression, and analog plotter output. Both the 2230 and 2220 have 100-ns glitch capture and digitize 20 million samples per second.

The 2220 is a follow-on to Tektronix' first portable storage scope, the 2200. The 2230 adds features such as triggered sweep delay, on-screen cursor measurements, on-screen parameter readout and menu selection, and vertical (in addition to horizontal) stored-waveform positioning. The 2220 and 2230 have a 4-K waveform record length.

The 2430 has a digitizing speed of 100 megasamples per second, enhanced glitch capture, pretrigger selections, on-screen parametric measurements, and Tektronix' save-on-delta mode. This allows the oscilloscope to compare incoming waveforms with a stored reference form and lets the unattended scope cap-

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Circle 77 on reader service card

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WILTRON

Circle 53 on reader service card

ture any signals that vary.

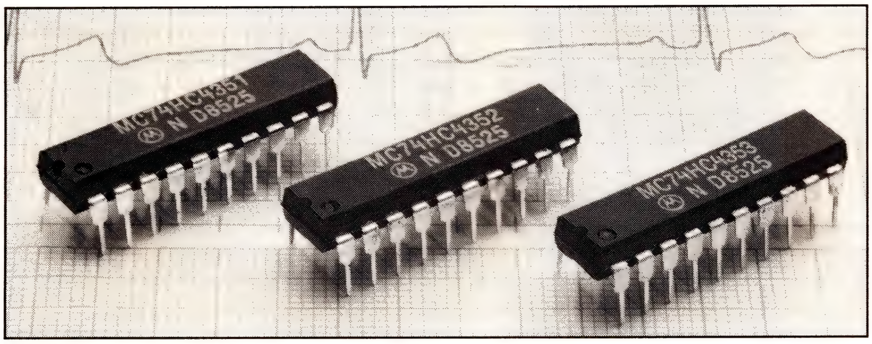
The fast digitizing speed was made possible by a proprietary charge-coupled device, the M800, that can take high-speed analog signal samples and provide a temporary storage of up to 1-K waveform record length. Performance is further accelerated by interleaved sampling, which is accomplished by setting the phase gates for sample clocks 180° out of phase with each other. This way, two samples are taken during each input clock cycle.

A technique that uses custom circuitry enables the 2430 to capture fast single-shot phenomena as brief as 2 ns in duration. Tektronix designed a clocked peak detector consisting of a custom large-scale analog IC and a hybrid thick-film circuit.

Voltage pulses as narrow as 2 ns can be captured even if they did not occur at the instant the input signal was sampled. A proprietary parallel-pipelined 16-bit microprocessor, the M275, handles only the digitized waveform data, allowing from 40 to 100 waveform acquisitions/s. All the scopes are available now for delivery. *–Eve Bennett*

Tektronix Inc., P. O. Box 1700, Beaverton, Ore. 97075.
Phone (503) 627-9000 [Circle 339]

MULTIPLEXERS GET ON-CHIP LATCHES



MIXED. Motorola's analog multiplexers gain digital control with on-chip latches.

High-speed CMOS logic is finally getting its place in the sun. HCMOS vendors are beginning to introduce new silicon-gate logic chips that mix a little analog circuitry with on-chip digital logic. These circuits, with their added features, are more than a match for bipolar parts. Motorola is brightening the picture with three new designs. The new circuits, analog multiplexers and demultiplexers, differ from traditional parts in that they have on-chip address latches.

The MC74HC4351 has a single eight-channel analog path. The 4352 features a dual four-channel analog path, and the 4353 contains three two-channel analog multiplexing/demultiplexing paths. Analog signals may be sent either way through the multiplexing/demultiplexing circuit.

Digital logic controls all three components, and the address latch can fix the part's channel-select input. Motorola has just recently begun fabricating these chips using a modified HCMOS process. The trick to mixing digital and analog is careful characterization along with new design-simulation programs, says Timothy Cleland, product planning engineer at Motorola's Logic and Special Functions Division.

The multiplexer/demultiplexers are intended for a wide range of analog equipment designs, including medical instrumentation and analog-to-digital conversion systems. The HCMOS parts are expected to become a standard logic circuit defined by Jedec soon.

The 18-pin logic components, which have dice measuring 105 by 120 mils, dissipate 500 mW. Unlike the standard silicon-gate logic devices, these multiplexer/demultiplexers can operate with analog input voltages up to 12 V. The chip can handle the swing in analog input voltages because of increased gate lengths in the modified HCMOS process, says Cleland. The digital control for the address latch uses the conventional 2- to 6-V power supply.

The parts also have lower and more linear on-resistance, compared to analog multiplexers made in metal-gate CMOS. The silicon-gate chips typically have an on-resistance of 70 Ω at 4.5 V compared with the 250 Ω at 5 V for traditional bipolar circuits.

The commercial-grade parts, housed in plastic, operate from –40°C to +85°C. Military-grade components, housed in ceramic DIPs, operate between –55°C and +125°C. Motorola also plans to sell the parts in standard 20-lead small-outline IC packages.

The analog multiplexer/demultiplexers will be available by the end of the month and will sell for $2.49 each in 1,000-piece quantities, housed in plastic DIPs. *–J. Robert Lineback*

Motorola Inc., MOS Logic and Special Functions Division, 3501 Ed Bluestein Blvd., Austin, Texas 78762.
Phone (512) 928-6880 [Circle 340]

MICRO-MAINFRAME LINK ADDS NETWORK CONTROL

Datastream Communications' niche has been to provide a gateway from various systems to IBM Corp.'s 3270. Now with its new modular 8000 family of network processors, Datastream is moving into network control and measurement. The series builds on one of the company's current software products, the Execulink, which links microcomputers to mainframes.

The 8030 goes beyond mere protocol conversion. In addition, it serves as the basis for building a network, automatically collects statistics on system activity, and controls access through an authorization table.

The low end of the 8000 series is the 8010 protocol-conversion system, which provides full 3270 Binary Synchronous Control and System Network Architecture emulation, IBM 3278 terminal emulation, and IBM 3287 printer compatibility. The 8010 system also is compatible with ASCII graphics standards. It comes with two synchronous ports, and thanks

MULTIFACETED. Datastream's processor integrates network-monitoring tasks.

to its modular design, it supports from 8 to 32 asynchronous ports.

Also standard is a 2-megabyte main memory and a 5¼-in. floppy-disk drive for loading software. Software allows the system to be reconfigured on-line without having to shut down the network. The company has made the design of the basic 8010, which sells for $9,900, upgradable in the field to become the 8030 network-management system.

The advanced 8030 model, priced from $14,900, comes with a 10-megabyte Winchester disk drive. Its software provides log-on statistics and on-line monitoring, which includes counting the types of user interactions. The network can maintain and monitor as many as 1,000 dial-in users.

Particularly useful for service industries that bill clients based on usage, the counting function measures keystrokes, throughput, line errors, and connections and disconnections. For security, the system registers the number of illegal access attempts.

With these features, the network operator can measure an individual's performance on the network and can troubleshoot by individual physical lines or at the logical level.

The operator can also view ongoing system activity and enable or disable communication lines, ports, and user identification. The company plans to add additional protocols, such as X.25, as they become popular, and will allow for other media interfaces, such as twisted-pair wire.

The network processors are available now; delivery takes 30 days after receipt of order. *–Eve Bennett*

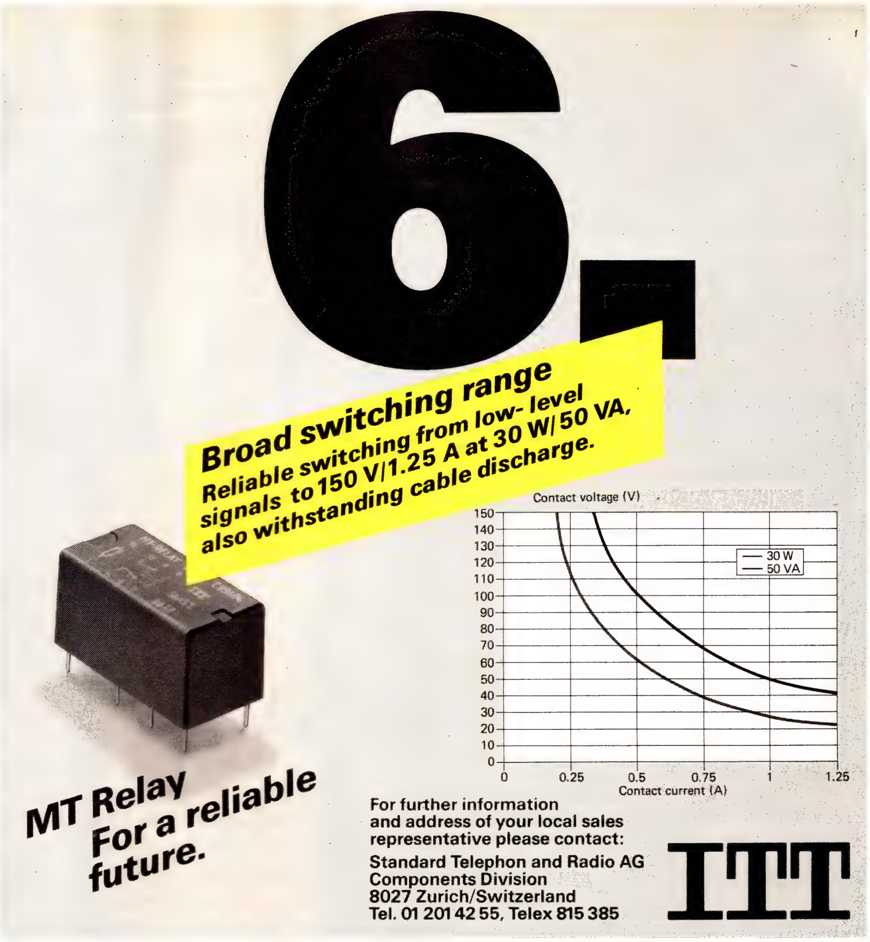
Datastream Communications Inc., 2520 Mission College Blvd., Santa Clara, Calif. 95050.
Phone (408) 986-8022 [Circle 341]

CONVERTER DISSIPATES 25% OF COMPETITION

A line of video-speed digital-to-analog converters operates in 8 ns within the military temperature range of –55°C to +125°C. The HDG family dissipates 730 mW maximum—up to 75% less than comparable devices, the company says.

Applications for the DACs, which have a maximum nonlinearity temperature coefficient of 30 ppm/°C, include color graphics displays, raster-scan displays, TV video reconstruction, and process-control systems that require fast settling times.

The hybrid converters come in three ranges of gray-scale output—8-, 6-, and 4-bit resolutions. The HDG-0405 accepts



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4 bits (16 levels) of digital input, the HDG-0605 has 6 bits (64 levels), and the HDG-0805 has 8 bits (256 levels).

In lots of 100 pieces, prices range from $30 to $103 each. Delivery takes three weeks.

Analog Devices Inc., Literature Center, 70
Shawmut Rd., Canton, Mass. 02021.
[Circle 384]

SINGLE CONVERTER HANDLES 3 COLORS

A single circuit, the Bt452, which combines a triple 4-bit digital-to-analog converter and a 16-by-12 color-lookup table, converts the digital color information into the red, green, and blue analog signals needed to drive a color monitor. With the chip, designers of graphics cards and systems can cut the number of converters required from three to one. The color-lookup table stores 16 levels of each color, giving the user a choice of 4,096 colors.

A second chip, the Bt444, omits the color-lookup table. Either converter can be used in color graphics terminals and personal-computer-based work stations with resolutions ranging from 640 by 480 pixels to 768 by 576 pixels. In the interlace mode, the converter supports resolutions of 1,024 by 800 pixels.

For both parts, integral and differential nonlinearity are guaranteed to be less than ±½ least significant bit over the full temperature and power-supply range.

Available from stock, the Bt452 costs $65 each in lots of 1,000 pieces and the Bt444 goes for $59 in like quantities.

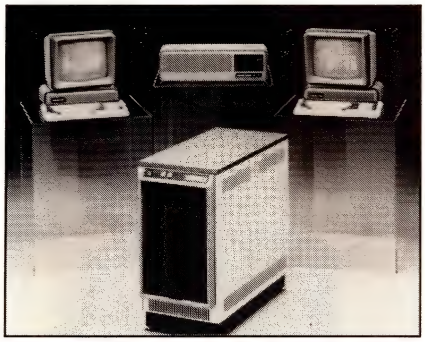
Brooktree Corp., 11175 Flintkote Ave.,
Building F, San Diego, Calif. 92121.
Phone (619) 452-7580 [Circle 385]

PERTEC COMPUTERS HOLD 600 MEGABYTES

The models 3250 and 3260 fill in the high end of Pertec Computer Corp.'s 3200 family, which consists of a line of multiuser, multitasking computers all based on the 68000 microprocessor. The 3250 and 3260 provide more than 600 megabytes of hard-disk storage, and backup options include ½-in. magnetic tape and streaming-cartridge tape. The work stations link to the CPU over a coaxial cable that transfers data at 10 times the speed of conventional RS-232-C lines.

Each work station comes complete with its own microprocessor. Thus applications programs and even the CP/M operating system can be downloaded from the central computer to the work station.

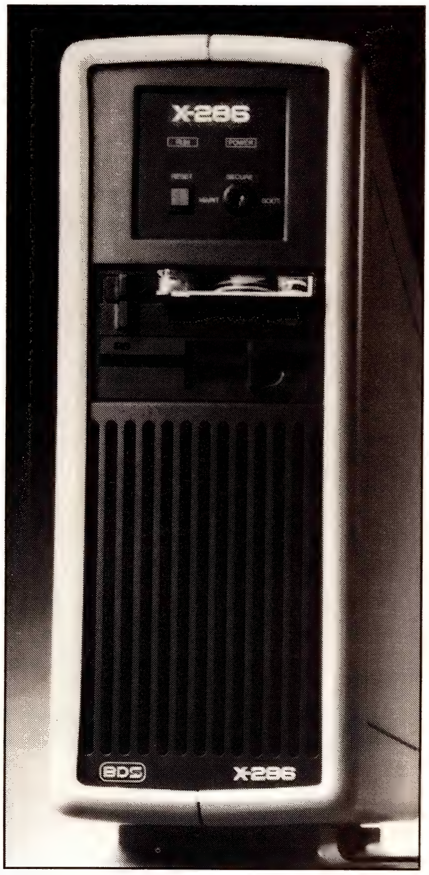
Applications software for the 3200 computer family includes tools for networking, data communications, and application development. Retail pricing begins at $26,000.



Pertec Computer Corp., 17112 Armstrong
Ave., Irvine, Calif. 92713.
Phone (714) 660-0488 [Circle 356]

80286-BASED UNIT RUNS XENIX 3.2

The Extended X-286, which runs under the Xenix 3.2 operating system, features up to 12 megabytes of no-wait-state RAM and up to two 380-megabyte, very fast, voice-coil-type Winchester disk drives. The system, with its OpenNet networking hardware and software plus 60 megabytes of cartridge-tape backup, is designed to fit into large business environments. Applications software for the Extended X-286 includes word processing, a calendar-scheduler, electronic mail, a spreadsheet, a data base, and graphics in one integrated package. A total of 19 I/O ports—18 serial and one parallel—are also standard. Prices start at $10,000.



BDS Inc., 1402 Shepard Dr., Sterling, Va.
22170. Phone (703) 430-0800 [Circle 357]

PROGRAM SIMULATES ANALOG CIRCUITS

Comtran, a program consisting of a set of four analog filter or amplifier design modules, runs with Basic 3.01 or 4.0 on the Hewlett-Packard 300 and HP 217 as well as on other HP computers. It is said to be more than 50 times faster than the original HP AC Circuits program. It optimizes active or passive circuits with up to 98 nodes, calculates group delay and relative phase, combines measurements with circuit models, and synthesizes active filter circuits using fewer operational amplifiers than are usually shown in textbook models.

Comtran comes on a demonstration disk at $750 per module; optional updates sell for $112.50 for the first year. These prices double for the HP 9020 computer, and the company offers quantity discounts for multiple work-station sites. The price of the manual is $35.

Jensen Transformers Inc., 10735 Burbank
Blvd., North Hollywood, Calif. 91601.
Phone (213) 876-0059 [Circle 358]

SPICE-LIKE PACKAGE RUNS ON MACINTOSH

A Spice-type drawing and analysis program, Micro-Cap II makes extensive use of the Apple Macintosh's mouse, windows, and pop-up menus. The program handles all common components and includes macro models for operational amplifiers and transmission lines.

Micro-Cap II also provides ac, dc, Fourier, and transient analysis of both linear and nonlinear circuits. Both temperature and worst-case analysis are available. An evaluation version, with a five-node limit, is available for $100. The full program costs $895.

Spectrum Software, 1021 S. Wolfe Rd.,
Sunnyvale, Calif. 94086.
Phone (408) 738-4387 [Circle 360]

SOFTWARE AIDS MCS-96 DESIGN

To make the job easier for designers who develop software applications for MCS-96 microcontrollers, the iDCX 96 distributed-control executive handles task management, scheduling, interrupt handling, and message-based communications between tasks—all in real time.

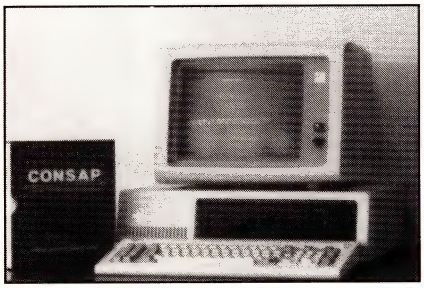
The iDCX 96 executive provides two interfaces for each system call. A PL/M-language interface stresses ease of use; a register interface provides high run-time speed. Because the executive occupies only 2.9-K bytes, it can be burned into PROM.

Designed to run on Intel's Intellec microcomputer development system and on the iPDS personal development system as well as on the IBM Corp. PC/XT and PC AT, iDCX 96 software sells for $750 for an evaluation license and $2,950 for a manufacturer's license. It is available for immediate delivery.

Intel Corp., Literature Department W-244, 3065 Bowers Ave., Santa Clara, Calif. 95051 [Circle 359]

PROGRAM DESIGNS CONTROL SYSTEMS

Consap version 2.0, an integrated software package for control-system designers, has been enhanced with graphics support and a simplified user interface. In addition, the program runs seven times faster when using the 8087 or 80287 math coprocessor.



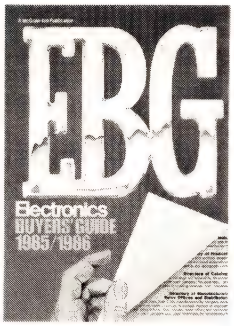
With Consap, the designer can define the system elements, combine them into a complete system, perform steady-state error analysis, and compute the system time response. The package automatically designs both analog and digital filters to tailor the system to the designer's specifications. A demonstration disk sells for $30, which is credited toward the purchase price of $695.

Integrated Motion Systems Inc., 141 W. Davies Ave., Suite 100, Littleton, Colo. 80120. Phone (303) 794-7973 [Circle 361]

72-K STATIC RAM HOLDS PARITY BIT

The 72-K MB81C79 CMOS static RAM has an 8-K-by-9-bit organization. The ninth bit, which permits storage of a parity bit for each stored byte, eliminates the need for a separate chip to store the parity data. The MB81C79 replaces standard 64-K static memories in applications where space is tight and a low parts count is critical.

Addressing time is either 55 or 45 ns, and the operating current is 160 mA, 25



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mA in standby. The MB81C79 is TTL-compatible and can be cascaded to build large memory arrays. Housed in a hermetically sealed 28-pin DIP, the memory is available now in sample quantities; production quantities are scheduled for the fourth quarter. The 45-ns chip sells for $23, the 55-ns chip for $19.

Fujitsu Microelectronics Inc., Marketing Communications, 3320 Scott Blvd., Santa Clara, Calif. 95054.
Phone (408) 727-1700 [Circle 363]

SRAM HOLDS DATA ON 50 MICROAMPERES

The model HM-65262, a 16-K CMOS static RAM, stands by on as little as 50 μA. The stability of the six-transistor memory-cell design guarantees a standby supply current of 100 μA over the full military temperature range, –55°C to +125°C, and protects against soft errors due to noise and alpha particles. It also raises the radiation tolerance of the RAM over that of devices with four-transistor cell designs.

The company also offers an industrial-grade part. Address-access times of 70 or 85 ns are available in both grades. Samples can be ordered for immediate delivery. The military-grade part sells for $67.07, the industrial-grade for $24.10—both in quantities of 100.

Harris Corp., Semiconductor Sector, P. O. Box 883, Melbourne, Fla. 32901.
Phone (305) 724-7800 [Circle 364]

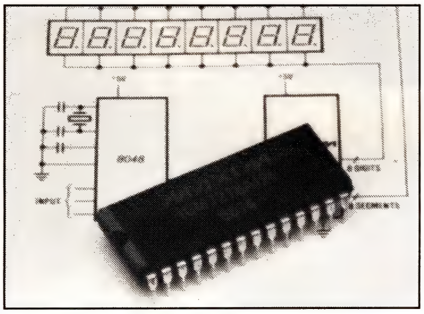
DRIVER CONTROLS 64 LED SEGMENTS

A complete single-chip LED display driver, the model ICM7218 individually controls each of 64 LED segments in a bargraph display or an annunciator panel. Four versions are available.

The brightest are the models ICM7218A and ICM7218C, which drive common-anode LED displays with 300 mA of digit-drive current. This means that no external buffers are needed. The ICM7218B and ICM7218D drive common-cathode displays with 50 mA of current.

All models come in either standard 28-lead ceramic or plastic DIPs. The plastic versions use a copper leadframe, which reduces thermal resistance to about half that of a plastic DIP built with Kovar or Alloy 42 leadframes. In orders of 100 pieces, the price is $5.09 each for plastic and $5.66 each for ceramic housing. Both are burned-in at 150°C.

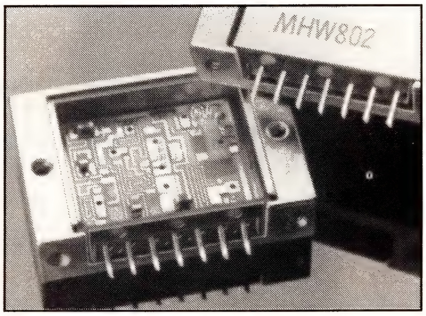
Maxim Integrated Products Inc., 510 N. Pastoria Ave., Sunnyvale, Calif. 94086.
Phone (408) 737-7600 [Circle 375]



POWER AMPS SERVE CELLULAR RADIO

Rated at 2.2 W output power, two ultra-high-frequency power modules target portable cellular radios. The manufacturer specifies the MHW802-1 for the 825- to 845-MHz band, standard in the U. S., and the MHW802-2 for the 890- to 915-MHz band, standard in Europe.

Each performs as a complete amplifier (with 50-Ω I/O capability) with no additional components required. The supply voltage is 9.5 V dc. The package includes a self-contained heat sink, safe to case temperatures of 100°C.



Samples and small volumes are available now, and large-volume orders will be filled in 8 to 10 weeks. For 100 to 499 pieces, the MHW802-1 costs $59, the European-band device is $63.

Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Ariz. 85036.
Phone (602) 244-3818 [Circle 376]

PULSE GENERATOR CONTROLS MOTORS

For numerically controlled machine-tool systems and robotics applications, the PCL-80K programmable single-chip pulse generator controls stepper motors and dc servomotors from a +5-V power supply. The 8-bit microprocessor's program generates the pulse for a single shaft; for operation of multiple shafts, units can be combined.

A 24-bit programmable binary counter is also on the large-scale CMOS chip. In lots of 1,000 pieces, the PCL-80K sells for under $40 each.

Kollmorgen Corp., Inland Motor Division, Stepper Motor Products, 4020 E. Inland Rd., Sierra Vista, Ariz. 85635.
Phone (602) 459-1150 [Circle 377]

TRANSISTOR SWITCHES WITH 600-PS DELAY

Manufactured in lateral double-diffused technology, the SD5000 family of analog switches and single transistors exhibits very short signal-propagation delays—600 ps with 680-Ω load—and low resistance—19 Ω. The products, which come in both the military and the industrial temperature ranges, suit a wide range of applications including analog switching, signal routing and multiplexing, chopper-stabilized amplifiers, and sample-and-hold circuits.

The SD5000 series quad DMOS switching arrays are manufactured in die form for hybrid and chip-on-board purposes and also come in 16-pin DIPs. The SD210 series of single DMOS transistors are available in TO-72 metal cans or in die form. All the transistors are available from stock, and prices start at $1 for 5,000 units.

Calogic Corp., 237 Whitney Pl., Fremont, Calif. 94539.
Phone (415) 656-2900 [Circle 378]

SYSTEM TAKES 100,000 READINGS/S

The HP 3852S data-acquisition system takes 100,000 dynamic readings per second and simultaneously performs static physical measurements with 1-μV sensitivity from thermocouples and resistance-temperature detectors. The system has applications in electrical, mechanical, or chemical testing as well as facilities monitoring.

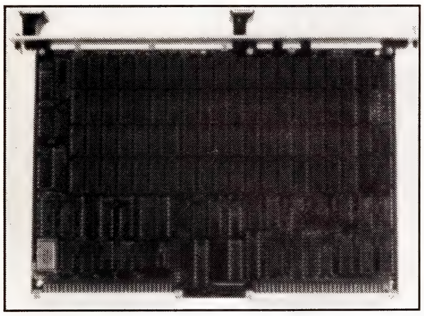
Firmware handles most reconfigurations, rather than hardware jumpers.

The complete system sells for $11,750 and consists of the data-acquisition and control-card cage mainframe; software written in Basic that includes graphics and process-control subprograms; and two digital multimeter cards. A choice of 17 plug-in card assemblies for an HP 9000 series 200 or 300 mainframe—switches, digital-to-analog converters, counters, actuators, and more—are variously priced. Delivery takes six weeks after ordering.

Hewlett-Packard Co., Inquiries Manager, 1820 Embarcadero Rd., Palo Alto, Calif. 94303 [Circle 379]

VMEBUS CARD HOLDS 2 MEGABYTES

The SVME-328 general-purpose RAM card for the VMEbus offers 2 megabytes of dynamic RAM with parity and status port for parity error. The front panel has two LEDs, one to show RAM parity error and the other to indicate system failure. Memory is partitioned into four blocks of nine 256-K-by-1-bit chips; the ninth bit is for parity. The SVME-328 also supports 64-K-by-1-bit chips, for 512-K bytes of memory.



The memory decoding can interleave two or four boards with every second or fourth word residing on the same card. An optional interleave with special-order programmable logic arrays is available. The SVME-328 card sells for $1,620 and is available now.

DY-4 Systems Inc., 1475 S. Bascom Ave., Suite 202, Campbell, Calif. 94008.
Phone (408) 377-9822 [Circle 366]

CARDS UPGRADE HP 3000 MEMORY

The HP600 series of 1-, 2-, and 4-megabyte memory cards from EMC will upgrade memory for Hewlett-Packard Co.'s HP 3000 computers, models 64 and 68. EMC cards can work in a system with HP memory cards.

The cards have an on-line/off-line switch so that if a user suspects system failure, he can disconnect a card both logically and electrically. The 1-, 2-, and 4-megabyte cards sell for $7,900, $14,200, and $25,500 each. All models are available now.

EMC Corp., 12 Mercer Rd., Natick, Mass. 01760. Phone (617) 655-6600 [Circle 367]

I/O MODULES SERVE GESPAC'S BUS

Three parallel, opto-isolated digital I/O modules allow any G-64/96-bus microcomputer system to control switch valves and relays. The digital modules also protect the system from overvoltages up to 1,500 V. The G-94/96 bus is a 16-bit bus aimed at midrange industrial applications. The boards can be connected to the 68000, 8088, Z-80, and a num-

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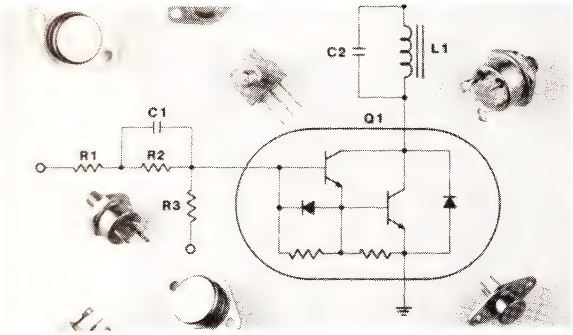

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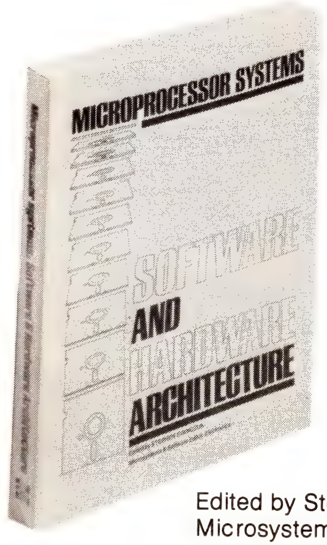

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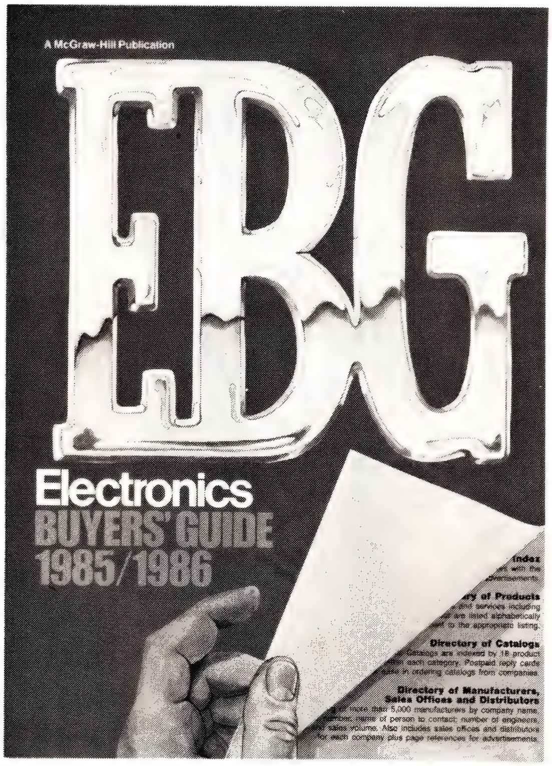
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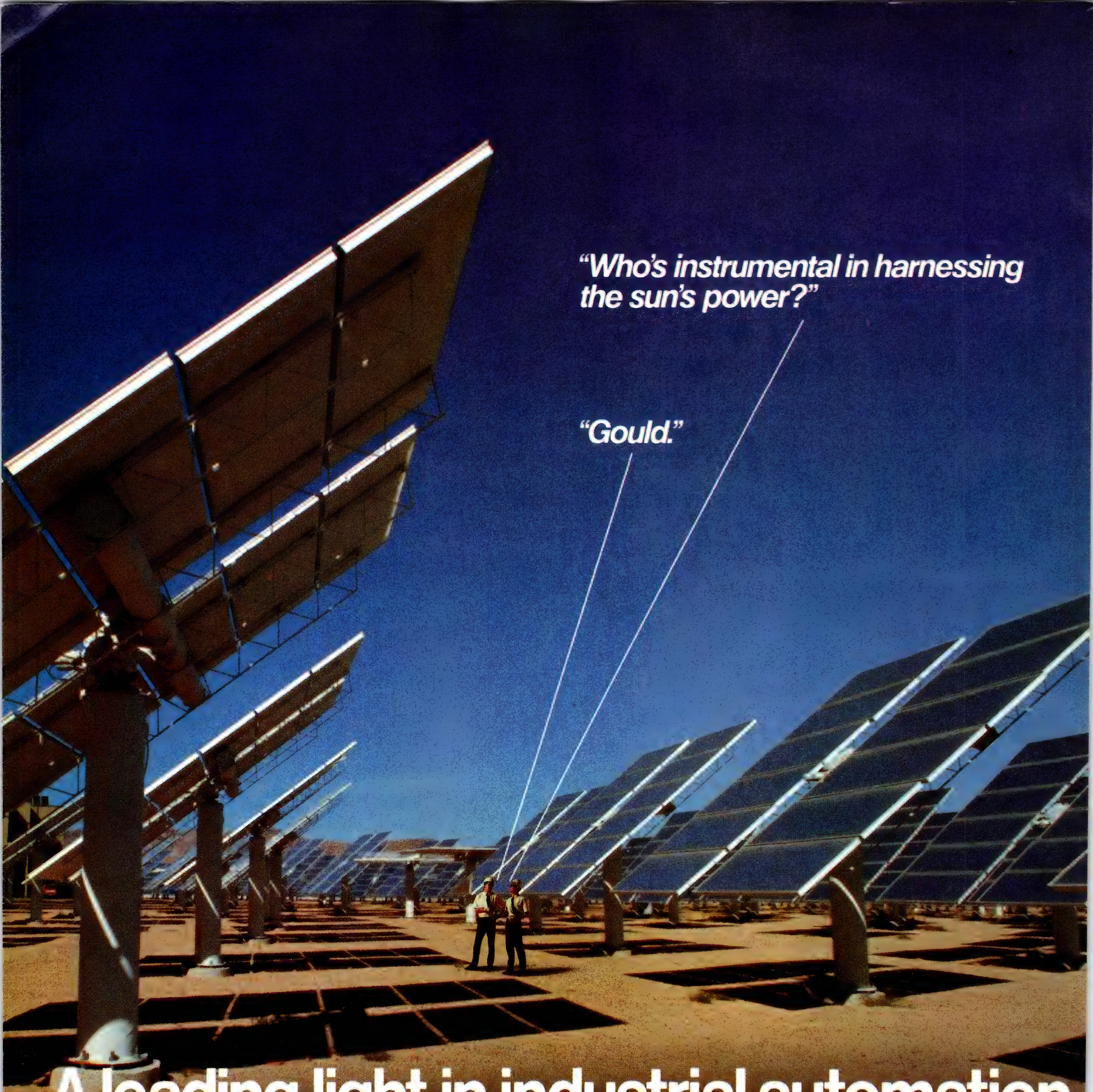

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All three boards are built on a standard single-height Eurocard and are available from stock. The Gesinp-1 and Gesinp-2 sell for $275 each; the Gescio-1 sells for $345.

Gespac Inc., 100 W. Hoover Ave., Suite 11, Mesa, Ariz. 85202.
Phone (800) 443-7722; in Arizona, (602) 962-5559 [Circle 368]

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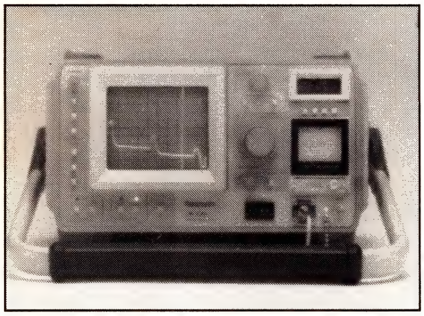

The reflectometer offers a variety of operating modes. In manual loss mode, a rotating marker measures splice loss; in automatic loss mode, the instrument automatically rotates the marker and displays splice-loss measurement; and in automatic dB/km mode, the instrument automatically displays loss per kilometer.

The price of the OF235 is $29,500, with delivery taking 12 weeks after receipt of order.

Tektronix Inc., P. O. Box 500, Beaverton, Ore. 97077.
Phone (503) 644-0161 [Circle 369]

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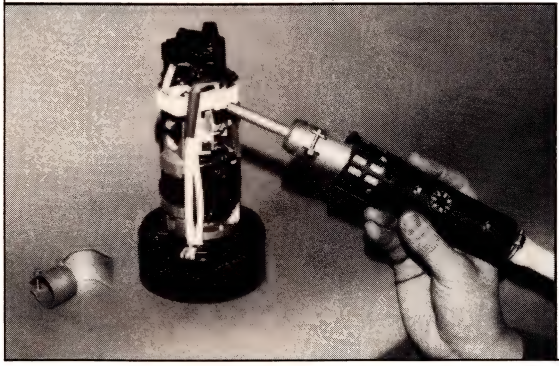

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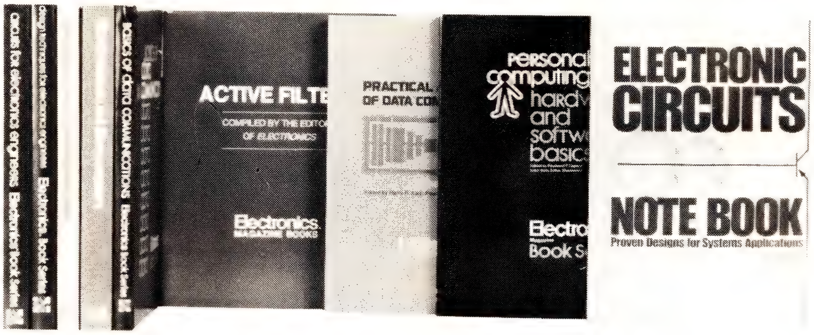
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Priced at $5,150, the PM 3295 is available now.

Philips Test and Measuring Inc., 85 McKee Dr., Mahwah, N. J. 07430.
Phone (201) 529-3800 [Circle 370]

LCR METER TESTS AT THREE FREQUENCIES

A $1,995 instrument for inspection and testing of inductors, capacitors, and resistors, the model 5110 programmable LCR meter performs at frequencies of 100 Hz, 120 Hz, and 1 kHz. A 3½-digit readout simultaneously displays dissipation and quality factor, and ranging can be manual or automatic.

For lossy test specimens, the instrument can be directed manually to display the equivalent parallel or series mode, or to select the appropriate mode automatically.

The capacitance range of the model 5110 is 0.1 pF to 19.99 mF, inductance is from 0.1 μH to 1.999 kH, and resistance is from 0.001 Ω to 19.99 MΩ. Test level is 1 V, with 50 mV available for characterizing semiconductor junctions. External dc bias to 30 V is available. Delivery takes about eight weeks.

Boonton Electronics Corp., 791 Rte. 10, Randolph, N. J. 07869.
Phone (201) 584-1077 [Circle 371]

DMA CONTROLLER RUNS AT 8 MHz

A direct-memory-access controller that offers a maximum clock frequency of 8 MHz, the 82C37A speeds data transfer to 4 megabytes per second. It also transfers data from one memory to another. The 82C37A is a static CMOS chip that will retain data even in a stop-clock standby mode, which makes it suitable for fully static CMOS systems. It is functionally equivalent to the industry-standard n-MOS 8237A.

The 82C37A's typical operating current is 2 mA/MHz, and the maximum standby current is 10 μA. Each of its four independent DMA channels has 64-K address and word-count capability and can be configured in software. To add channels, the DMAs can be cascaded.

In quantities of 100 to 999, the version of the 82C37A DMA controller that conforms to the commercial temperature range sells for $33.70 in plastic and $35.99 for a ceramic DIP. Industrial and military models are also available.

Harris Corp., Semiconductor Sector, P. O. Box 883, Melbourne, Fla. 32901.
Phone (305) 724-7800 [Circle 350]

CHIP COMBINES SIX DRIVERS, RECEIVERS

The MC145406 chip combines three drivers and three receivers in a single 16-pin package. The manufacturer claims this is the first silicon-gate CMOS IC to fulfill the electrical specifications of the RS-232-C standard and the CCITT V.28 standard in a single device. The power-efficient driver-receiver dissipates less than 15 mW, maximum. The drivers feature true TTL input compatibility and a slew-rate maximum of 30 V/μs; the receivers can handle up to ±25 V while presenting impedance of 3 to 7 kΩ.

The driver-receiver is available in a 16-pin plastic standard DIP, costing $1.11 each in 10,000-piece quantities.

Motorola Inc., MOS Logic and Analog Integrated Circuits Division, P. O. Box 6000, Austin, Texas 78762.
Phone (512) 928-6985 [Circle 351]

TRANSCEIVER IC RUNS ETHERNET PROTOCOLS

The 82502 transceiver chip performs all transmit, receive, and collision-detection functions of the Ethernet and Cheapernet protocols for 10-Mb/s operation. Implemented in Intel Corp.'s CHMOS technology, the IC can be powered with a low-cost dc-to-dc converter. The company says a complete large-scale-integration-based system solution can be built when the chip is teamed with the 82586 local-area-network coprocessor and the 82501 serial interface.

The 82502 transceiver will be available in sample quantities this month, and volume production will begin in the first quarter of 1986. In quantities of 1,000, the 82502 costs $24 each.

Intel Corp., Literature Department W-241, 3065 Bowers Ave., Santa Clara, Calif. 95051 [Circle 352]

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Electronics
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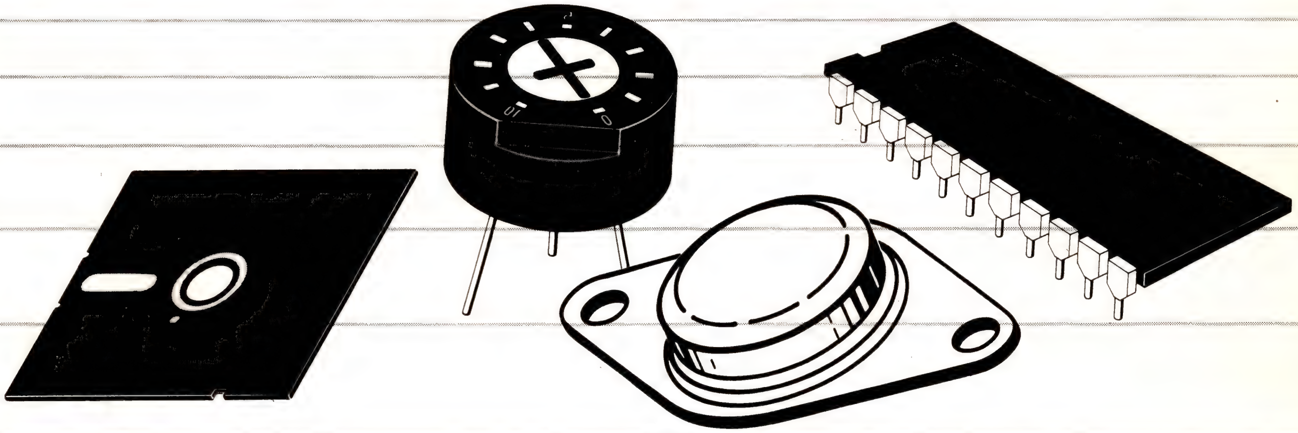

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POWER SUPPLIES. This brochure covers 58 models of Sorenson Co.'s resistance, voltage, and IEEE-488 programmable power instruments. The units suit computerized laboratory and industrial applications; for example, the new listener-talker 488 Micro DAP digital-to-analog interface has eight logic-controlled outputs. The XT series of programmable 60-W linear power supplies features twin LED analog bar graphs below the digital display. Tables and data are also given for three other series of power supplies. Call (603) 668-4500 to receive a free copy of the publication. The mailing address is 676 Island Pond Rd., Manchester, N. H. 03103. [Circle reader service number 421]

HARDWARE. A 204-page catalog from Globe Electronic Hardware Inc. describes in detail new lines of handles, handle ferrules, and IEEE jack screws. Other available parts include captive panel screws, panel retainers, thumbscrews, and insulating washers. The company offers 41 protective and decorative platings and finishes, which conform to military and other standards. Parts will be custom designed on special order, including variations in body or thread length, head configuration, and finish. Complete specifications are given in the catalog. Request the volume by calling (718) 278-2400, or write to Globe at 32-02 57th St., Woodside, N. Y. 11377. [Circle 422]

SIGNAL PROCESSOR. A 16-page user-tool brochure for Honeywell's electro-optical signal processor—designed under the Very High-Speed Integrated Circuits program—advises systems engineers and microprogrammers on how to make the best use of this integrated chip set. The signal processor, with a throughput of over 800 million operations/s with 32 programmable parallel pipeline chips, was developed for defense applications. The brochure guides the user through the hardware, software, and documentation and concludes with a review of several chips and modules from the Signal Processing Technologies Division. The company distributes the brochure from its offices at 1150 E. Cheyenne Mountain Blvd., Colorado Springs, Colo. 80906. Phone (303) 571-1000. [Circle 424]

TEST SYSTEM. The series 8510 multitasking automatic test system, including specifications, is presented in a four-page color brochure from Wayne Kerr Inc. The system provides for four categories of work station—test stations, on- and off-line programming stations, repair stations, and a computer-aided-design link, each of which is described in this free literature. Address inquiries to 600 W. Cummings Park, Woburn, Mass. 01801, or call (617) 938-8390. [Circle 423]

LABELS. Fifteen bar-code formats, including code 39, interleaved 2 of 5, and code 128, are illustrated in a free reference sheet that describes Computype Inc.'s library for tracking pc boards. The labels are manufactured in a number of formats, sizes, and symbologies, and for a range of applications from laboratories to heavy industry and materials handling. Call (800) 328-0852 toll-free for a copy of this literature, intended for the electronics industry; or write to 2285 W. County Road C, St. Paul, Minn. 55113. [Circle 425]

OFFICE AUTOMATION. Free literature describes Concept III, an office-automation system that includes two network controllers and two work stations. In its largest configuration, Concept III can link up to 28 work stations. A 4-megabyte archive-retrieval service, Library Services, and a number of other software choices, including the Xenix Applications Library, round out the system. For a copy of the brochure from Lanier Business Products Inc., call the company at (404) 329-8000. The company's address is 1700 Chantilly Dr. N. E., Atlanta, Ga. 30324. [Circle 427]

ANNUNCIATORS. CRT-display annunciation systems are some of the products described in this free catalog from Beta Products Inc., a manufacturer of monitoring and other industrial equipment. Other instruments covered are integral and remote window annunciators; microprocessor-based LED annunciators; and graphic annunciators. The catalog describes each model fully and also presents a wide range of custom assemblies and options. To receive a copy, write to Beta Products at 2029 McKenzie Dr., Carrollton, Texas 75011, or call (214) 242-0644. [Circle 428]

GATE ARRAYS. Issue 2 of the 2000 series double-layer-metal gate arrays handbook is now available from the IC Division of Marconi Electronic Devices. The handbook contains information on propagation delays and drive capability for all input, output, and internal cells. It is available on request from the IC Division's Publicity Liaison Manager, Doddington Rd., Lincoln LN6 3LF, England. [Circle 429]

TRANSFORMERS. The TRW Electronic Assemblies Division has published a 56-page catalog of its complete line of military-qualified and industrial products, grouped in the following categories: audio transformers, power transformers, switch power magnetics, pulse transformers, high-Q coils, and electric-wave filters. Dimensions and specifications are given, and schematics and circuits plus response curves and other graphic data presentations round out descriptions of the components. For information, or to receive a free copy, write the Transformer and Coil Products Operation at 150 Varick St., New York, N. Y. 10020; phone (212) 255-3500. [Circle 430]

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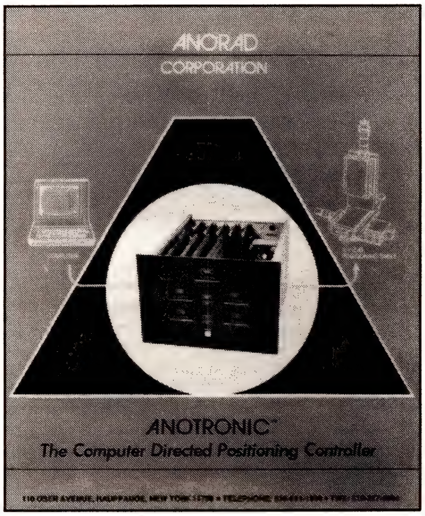

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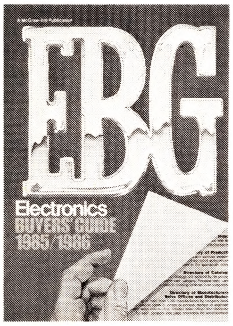

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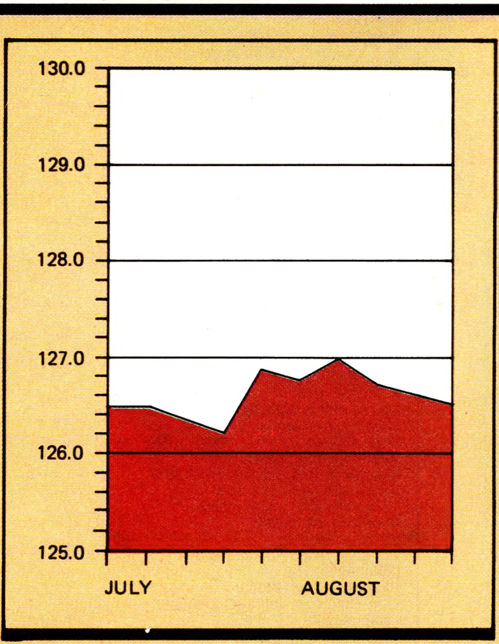

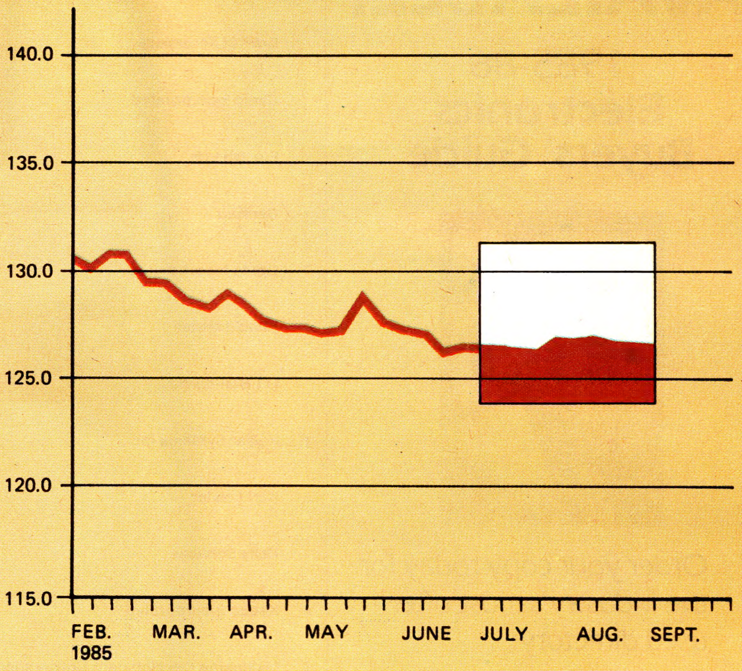

THIS WEEK = 126.5
LAST WEEK = 126.6
YEAR AGO = 129.9
1982 = 100.0

The *Electronics* Index, a seasonally adjusted measure of the U.S. electronics industry's health, is a weighted average of various indicators. Different indicators will appear from week to week.

U. S. GENERAL ECONOMIC INDICATORS

	July 1985	June 1985	July 1984
Index of leading economic indicators	168.7	168.0	163.9
Budgeted outlays of the federal government ($ billions)	78.012	71.506	68.432
Budgeted outlays of the Department of Defense ($ billions)	22.140	20.815	18.870
Industrial-production index	78.1	78.3	80.8
Operating rate of all industries (% capacity)	124.9	124.7	123.2
Total housing starts (annual rate in thousands)	1,654	1,694	1,730

U. S. ELECTRONICS SHIPMENTS

Shipments ($ billions)	July 1985	June 1985	July 1984
Communications equipment	4.831	5.229	4.394
Radio and TV receiving equipment	0.902	0.843	0.841
Electronic and electrical instruments	4.841	4.896	4.544
Components	3.184	3.315	3.834

After two months of steadily increasing sales, U. S. electronics-industry shipments in July dropped by nearly 4%, knocking the *Electronics* Index down a notch for the latest week. Total electronics-industry shipments have been absolutely flat in the past 12 months: according to the latest government statistics, shipments of U. S.-made electronic equipment gained only 1.1% compared with July 1984. That's hardly the sort of performance to give solace to beleagured manufacturers.

It was somewhat surprising that the most dramatic decline in July shipments was not in the components or consumer-electronics sectors but in communications equipment. Shipments in this formerly strong market fell 7.6%. At the same time, the continuing glut of semiconductor devices pushed down sales of components by 4%. In addition, instrument shipments were down 1%.

But all the indicators were not negative. There was an upside to the most recent slide in electronics-industry shipments: after sinking precariously for months, radio and TV sales were up an unprecedented 7% in July.

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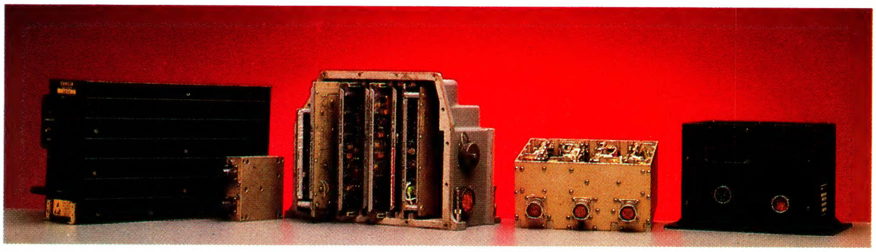

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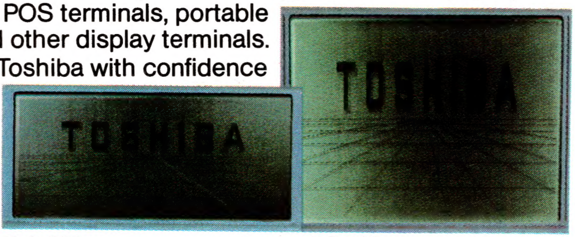
These versatile LCDs are ideally suited for applications as displays for personal computers, POS terminals, portable word processors and other display terminals. You can also look to Toshiba with confidence for a wide range of sizes and display capacity to suit your LCD requirements.



TLC-363 *TLC-402*

Specifications

		TLC-402	TLC-363B
Display			
Number of Characters		80×25 (2,000 characters)	80×25 (2,000 characters)
Dot Format		8×8, alpha-numeric	8×8, alpha-numeric
Overall Dimensions (W × H × D)		274.8×240.6×17.0 mm	275.0×126.0×15.0 mm
Maximum Ratings			
Storage Temperature		−20° – 70° C	−20° – 70° C
Operating Temperature		0° – 50° C	0° – 50° C
Supply Voltage	VDD	7 V	7 V
	VDD – VEE	20 V	20 V
Input Voltage		0≤VIN≤VDD	VSS≤VIN≤VDD
Recommended Operating Conditions			
Supply Voltage	VDD	5±0.25V	5±0.25V
	VEE	−11±3V Var.	−11±3V Var.
Input Voltage	High	VDD – 0.5V min.	VDD – 0.5V min.
	Low	0.5V max.	0.5V max.
Typical Characteristics (25°C)			
Response Time	Turn ON	300 ms	300 ms
	Turn OFF	300 ms	300 ms
Contrast Ratio		3	3
Viewing Angle		15 – 35 degrees	15 – 35 degrees

Design and specifications are subject to change without notice.

TOSHIBA

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